POWER

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DEAD CATS

• *"There are going to be a lot of dead cats* flying around pretty soon, and I want men around me who won't run"—Gen. Hugh Johnson, defending his choice of tested hard-fisted sidekicks in the job of administering national recovery.

• *No debating society for this man;* he's a soldier. Washington is organizing for action and nothing else. If you doubt it, run down and meet the leaders face to face: General Johnson, Douglas (Budget Director) Wallace (Secretary of Agriculture) and the rest of them.

• *What is going on down there* is not power engineering, but power engineers as industrial executives ought to know something about an Act and actions that will affect every industry and every Tom, Dick and Harry in the whole U. S.

• *The average engineer,* depending on local papers for disconnected bits of news, finds himself confused. Yet it's pretty simple if you take General Johnson's advice. "Don't guess, don't surmise—read the law," he says over and over. He means just that.

• *Turn to page 416* of this number for a brief catechism in plain English. It will help you to key your power decisions to present-day business facts. And it will help you, as a plant executive, to contribute your bit of sane thinking when associates start the endless gossip, mostly wrong, about NIRA.

• *The facts are just as exciting* as the fictions and a lot more useful.

"Mb" or "kB"

• It's fun to be different, but it's sometimes more fun to adopt established good practices.

At the recent A.S.H.V.E. meeting in Detroit, the old argument popped up about a short name for 1,000 B.t.u. It was pointed out that the A.S.M.E. had already agreed upon and published a standard symbol *"kB."* This seemed good enough for A.S.H.V.E. members until speakers recalled certain points of disagreement with A.S.M.E. policy on matters far removed from that under discussion. Thereupon it was recommended that A.S.H.V.E. have its own private brand of 1,000 B.t.u. and call it *"Mb."*

The virtue of symbols lies in uniformity. Why curse engineering with another variation just for the sake of being different?

Fire Under Water

• Underwater combustion, known and largely neglected for some years, commands new attention. Burners to operate under water are on the market. Equipment costs are low. Evaporative efficiencies approach 100 per cent.

The notable disadvantage is the fact that combustion products mix with the vapor. This apparently rules out the under-water burner as a steam maker for condensing engines and turbines. In many other applications, including the concentration of chemical solutions and mixtures, the gases cause no trouble.

The article on page 402 deals with this subject, not as a scientific curiosity, but rather as a commercial process which has many applications of practical interest to power engineers.

Two-Stage Condensing

• Under proper conditions, a lot of money can be saved by heating water in two stages. The same applies to two-stage condensing. (See page 428.)

With this arrangement, cooling water passes first to the usual condenser attached to the turbine exhaust. It then does double service by condensing steam bled from a low-pressure stage.

For a moderate sacrifice in efficiency, two-stage condensing reduces circulating water 50 to 80 per cent. It thereby opens a much broader field for cooling towers and greatly increases the possible capacity of steam power plants situated on streams of low flow.

Class 2—Not 2nd Class

• It is time to clear up a notion that never had any basis in fact. The A.S.M.E. Pressure Vessel Code groups vessels in "classes" according to the type of service. For each class it prescribes safe welding and design requirements. The idea has gone abroad that the requirements for "Class 2" vessels constitute "second-class" welding, which isn't true at all. Requirements for "Class 2" vessels are entirely safe, adequate and first-class for the specified services.

Failure of users to understand this is placing on them a heavy burden of unnecessary investment.

70 Stories—48 seconds

• High buildings demand fast elevators, and America is getting both. Witness Rockefeller Center, popularly known as Radio City. Operated at 1,200 F.P.M., some of the R.C. elevators have been tested up to 1,500. Allowing 12 stories for speeding up and slowing down, they make the 70-story lift, from landing to landing, in 48 seconds. Read this month's leading article for details.

Hot Summer

• It will be a hot summer in Washington. NIRA is getting up steam in the national boiler room. Back in the White House sits the Chief Engineer reading the instrument charts and giving orders to his watch engineers.

The load is coming on rapidly with no limit in sight. But $3,300,000,000 in public-works coal is piled up in the yard. Equipment and men are ready. There's a plan and a boss.

Prospects are that the load will be carried without a hitch—but it will be a hot summer in Washington.

POWER Stands for

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Fig. 1—The 1,200 f.p.m. elevators are each operated by a 100-hp. motor

ROCKEFELLER CENTER ELEVATORS

Operate at 1,200 F.P.M.

In the main building are 75 elevators, 24 of which normally operate at 1,200 f.p.m. Some of the cars have run at 1,500 f.p.m., and one car has been tested and approved by the city inspectors to operate at 1,400 f.p.m.

THE great 70-story tower building in Rockefeller Center is the latest addition to New York's ever-increasing number of imposing skyscrapers. This building occupies an area of 191x535 ft. between 49th and 50th Sts., in a block extending from 5th to 6th Aves. It has a gross floor area of 2,900,000 sq.ft. and rises to a height of 850 ft. above the street level.

In a building of such gigantic proportions, vertical transportation is one of the most important services. This will be provided for by 75 Westinghouse elevators and 6 Otis escalators, four of the latter running from the shopping basement to the ground floor and two operating from the ground floor to the mezzanine. The table lists the elevators and their principal data.

Of the 75 elevators, 24 normally rated 3,500 lb. at 1,200 f.p.m. are of particular interest as they are the highest-speed passenger elevators in operation. Some of them have been operated at 1,500 f.p.m. during performance tests, and one has been approved by the city inspectors to operate at 1,400 f.p.m. These elevators are of the automatic-landing type; they travel from 497 to 779 ft., and some of them represent a total suspended load of about 25,530 lb.

The highest-rise cars make a round trip with terminal stops only in 95 sec. They will be in motion about 58 per cent of the time and for 40 per cent of the time will be running at full speed. These duties and the long express runs involved require an elevator-machine motor with a rating of 100 hp. To meet such requirements, almost an entirely new line of equipment was necessary.

A new gearless traction-elevator motor, weighing 23,500 lb., was developed for this service. A number of new and difficult control problems were encountered due to the wide range of speed over which the elevator motors must operate. Variable-voltage, full-automatic control is used, and in order to obtain uniform retardation and low speeds for making the landings a special motor-generator set was developed having pole-face windings and special brush-holders to minimize the effects of temperature changes.

Extremely close speed regulation is essential for accurate stops at the floors, and this involves close regulation of all voltages. The exciter on each of the motor-generator sets is equipped with a voltage regulator to eliminate the variables in this element. Since a 1,200-f.p.m. elevator requires 12 floors to accelerate from standstill to full speed and then retard to a dead stop, the control had to be specially developed to stop accurately for shorter runs as well as for a full run.

In the solution of these problems, a new inductor selector having a positive drive and direct ratio between car travel and selector movement was developed. The selector carriage functions only in the zone of the floors served, so that the over-all height of the selector is greatly reduced, as is evident in Fig. 3.

The high-rise cars have a travel of 779 ft. This introduced a problem at the ground floor, due to stretch of the ropes when loading and unloading the car. A stopping and leveling relay, using a photo-electric cell, brings the car back to the floor when it moves away $\frac{1}{2}$ in., because of rope stretch.

These cars are equipped with every modern convenience and safeguard. All have individual power hoistway-door operators. The car and hoistway doors are protected by the Safe-T-Ray, which automatically prevents them from striking or injuring an entering passenger. Sixty-five of the gearless elevators are equipped with a new lock-down compensator sheave to prevent jumping of either car or counterweight under emergency stopping conditions.

Two new safeties, designed to meet the exacting requirements of the American Standards Association and the New York City codes, are installed on each elevator. one under the car platform and one on the counterweight. It is usual practice on elevators of ordinary speeds to install an oil buffer in the pit to stop the car should it overtravel the bottom terminal. For a car at 1,200 f.p.m. this requires a buffer so long in stroke that its design becomes difficult and its installation sometimes impossible. A special terminal-stopping device therefore was developed, together with a new inertia-type governor and a terminal-stop control, which will automatically set the car safety should the elevator approach the terminal at a speed in excess of a predetermined value. This enables the use of normal short-stroke buffers in the pits.

To avoid excessive weight of the larger number of standard elevator hoist ropes, which the heavy duty and long travel made necessary, a special $\frac{11}{16}$-in., 8x19 composite-steel rope, 62 per cent stronger than a standard $\frac{5}{8}$-in., 8x19 rope. was developed by the American Steel & Wire Co. for these elevators. These ropes, each having a normal rating of 32,400 lb., operate on special hardened traction sheaves and saved a total of 16 tons dead weight on 36 cars. The hoist ropes are connected to the cars by Evans equalizers, designed so that the car can be adjusted to float between the guide rails.

The guide rails are fastened to the building through floating guide-rail clips. This type of fastening permits the rails to slide up or down, thus maintaining alignment under all conditions of building compression, which is one of the secrets of riding comfort.

In the cars, the operators' panels are comparatively simple, as shown in Fig. 2. There is the usual bank of floor-call buttons at the top of the panel. These buttons are of the lock-in type, but each can be released after being set by a small button below it. On each side of the bank of call buttons are two rows of numerals, one for up direction and the other for down, corresponding to the floor numbers. The numerals are illuminated by the waiting-passenger calls from the different floors. By this means the operator knows at all times on what floors passengers are waiting.

Just below the bank of floor stop buttons are three others. The one on the right is to bypass the floor calls, the center one is the emergency stop. If this button is pressed the car will stop as quickly as can be done safely. The button on the left is the next-stop control. If the car is in motion, and for any reason it is desired to stop, by pressing the next-stop button the car will slow down and make a stop at the next landing reached by a normal stop. For example, a 6-floor run is required to make a normal stop from 1,200 ft. per min. If the car were operating at 1,200 ft. per min. and the next-stop button was pressed, it would stop at a floor 6 floors away from where the next-stop button was pressed.

When the car has been stopped by the next-stop button, it may be started in either direction by pressing the terminal button for the direction desired and moving the control handle to the normal-run position. If the car is running in the up direction when the next-stop button is pressed, then after the car has come to rest, if the bottom terminal button is pressed the car will start down and operate in a normal manner when the operating lever is moved to the run position. When the car is stopped at an intermediate landing its direction may be reversed by pressing the button corresponding to the opposite terminal from that toward which it was traveling and moving the operating lever to the run position.

At about the center of the control panel are the two operating levers. The one on the right is for normal automatic control. Moving the lever up will close the doors, but the car will not start. This position of the

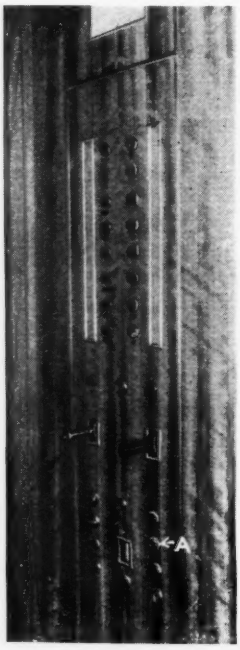

Fig. 2 (left)—Operator's panel in one of the highest-rise cars

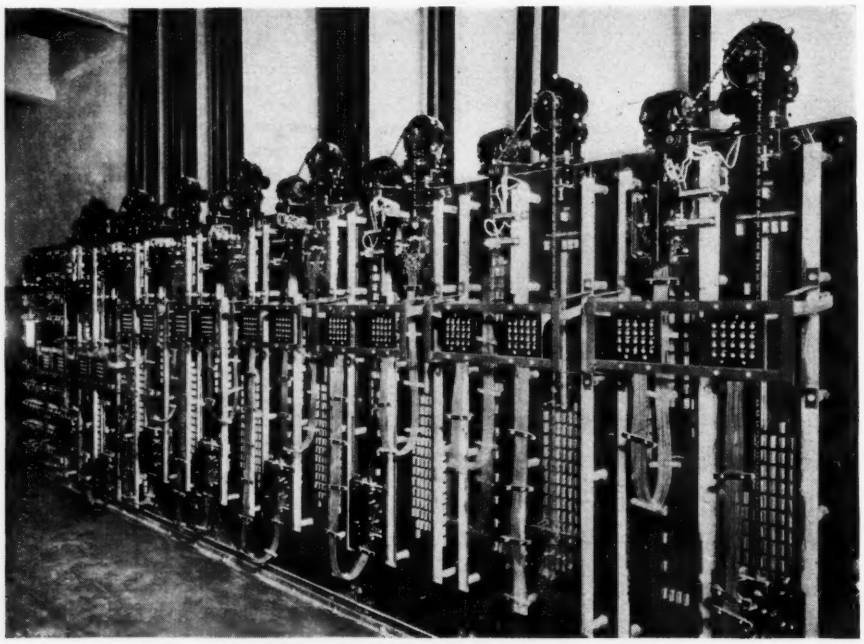

Fig. 3 (right)—Floor selectors for the cars that rise 779 ft. Note their short overall height for that travel

operating lever is intended chiefly for checking operation of the doors and for closing the doors when the car is waiting its turn at the ground floor to take on passengers. When the control lever is moved to the down position, the doors close and the car operates normally under automatic control.

By pressing button *A* at the bottom of the panel, operation is changed from automatic to manual control by the left-hand operating lever. On manual control the car will run at a maximum speed of about 100 f.p.m.

Below the control levers is a key switch for starting and stopping the motor-generator set and a light that shows red when the set is running. There are three switches in the control circuit of the motor-generator set. One of these is on the starter's panel on the ground floor, one in the car, and one on the control panel in the machine room. All are connected in series, consequently if the motor generator is shut down from one location it cannot be started again until that switch is closed. This arrangement insures against the machine being started unexpectedly when someone may be working on it.

At the bottom of the control panel in the car there are also two switches for control of the fan in the car, a switch for the car lights, a switch for the Safe-T-Ray on the doors, a telephone jack for use when working on the car and wiring, a buzzer controlled from the starter's panel, a signal reset button, a car- and a hoistway-door bypass under glass and, as previously mentioned, a button to switch from automatic to manual control.

Two of the high-rise cars are equipped for night service. These cars in addition to having an operator's panel for express service, have operating panels for night service. On the night-service panels are buttons and annunciators for all floors not served by express service. A combination control from the night-service and the express panels allows the elevator to serve all floors. The controls on these cars have both an express-service and a night-service selector. To change from the express to the night-service selector the operator pushes a button on the night-service panel and the change is made automatically.

Fig. 4 (left)—Dispatcher's hall-button telltale annunciator. Fig. 5 (right)—Car-position indicator above ground terminal-landing doors and the dispatcher's station on the right

PRINCIPAL DATA ON THE 75 ELEVATORS

No. of Cars	Floor Rise	Express	Local	Duty	Capacity Pounds	Speed F.P.M
1 to 8	G. to 16	.....	G. to 16	Pass.	3,500	800
9 to 16	G. to 29	G. to 14	14 to 29	Pass.	3,500	1,000
17 to 24	G. to 42	G. to 28	28 to 42	Pass.	3,500	1,200
25 to 32	G. to 55	G. to 41	41 to 55	Pass.	3,500	1,200
33 to 40	G. to 65	G. to 53	53 to 65	Pass.	3,500	1,200
41 to 44	S.B. to 65	.....	S.B. to 65	Service	3,500b	700
45 to 52	G. to 9	.....	G. to 9	S. Pass.	3,500	800
53 to 56	2 to 9	.....	2 to 9	S. Pass.	3,500	700
57 & 58	S.B., 2 to 10	.....	S.B., 2 to 10	S. Serv.	6,300	500
59 to 64	B. to 16	.....	B. to 16	Pass.	3,000	800
65	S.B. to 16	.....	S.B. to 16	Serv.	4,000c	500
66 & 67	S.B. to M.	.....	S.B. to M.	Serv.	4,000	100
68 & 69	S.B. to G.	.....	S.B. to G.	Serv.	8,000	100
70	65 to 69	.....	65 to 69	Pass.	2,500	200
71 & 72	B. to M.	.....	B. to M.	Pass.	4,000	300
73 & 74	B. to M.	.....	B. to M.	Pass.	4,000	200
75	Br. to S.B.	.....	Br. to S.B.	Frgt.	3,000	60

G. — Ground floor; S.B. — Sub-basement; B — Basement; Br. — Boiler-room; M. — Mezzanine; S. — Broadcasting Studio. a — Cars 37 & 39 travel down to the basement and have 52 additional openings for night service; b — No. 44 car safe-lift capacity, 6,000 lb.; c — Safe-lift capacity, 6,000 lb.

The cars are arranged in groups of eight, four on each side of a loading aisle. Installed in the wall on one side of the aisle is the telltale annunciator, Fig. 4, on which is indicated the hall buttons that have been pressed by waiting passengers. Just below this annunciator are two Telechron clocks that ring bells at the top and the bottom terminals, at regular intervals, to indicate when a car is to leave the landing.

On the opposite wall of the loading aisle is the car dispatcher's station, Fig. 5. On the panel in this station are a key starting switch and a light for each motor-generator set, the starter's call-back buttons, the floor-signal bypass buttons, and a button to illuminate the night-service signs on each floor. When only the night-service cars are running, by pressing a button on the starter panel, signs are illuminated on each floor that read "Use Night-Service Cars."

Over the ground-floor terminal landing doors on each elevator are the car-position indicators, Fig. 5. Above the hoistway doors on each floor are the usual floor lanterns to indicate when a car is approaching a floor and the direction in which it is going.

From the foregoing it is evident that the car control and signal equipment are simple and involve only those devices essential to intelligent dispatching and operating of the cars. The novel features of the equipment are in the motor and control rooms and in the hoistway. These are the devices that had to be developed to meet the exacting requirements of automatically landing the cars accurately at the floors when operating at the high speeds employed in this installation.

The architects for the building are Reinhard & Hofmeister; Corbet, Harrison & MacMurray; and Hood & Fouilhoux. Hegeman-Harris Co., Inc., are the general contractors for the building. Todd, Robertson, Todd; Todd Engineering Corp.; and Todd & Brown, Inc., are the builders and managers. Clyde R. Place, consulting engineer in charge of the mechanical and electrical features of the project, also worked out the detailed plans and specifications for the elevator system. All required hoistway clearances, elevator machine rooms, structural steel design for overhead work, pits and other parts were so arranged in these plans that no modifications were required after the elevator contract was finally executed.

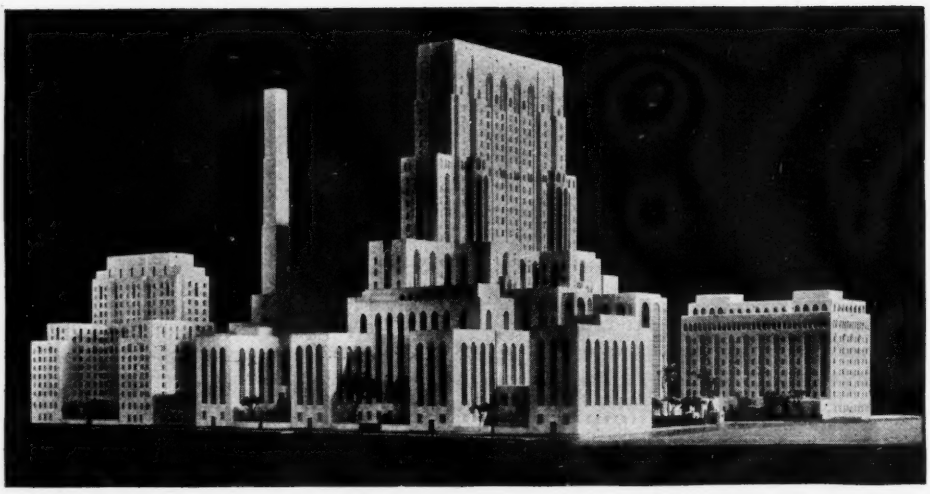

Fig. 1—The tall tower is the main hospital, with the Cornell Medical College in front of it. The power plant is at left, behind the college; the Nurses' Home at extreme left and the Psychiatry Building at extreme right

RELIABILITY—

KEYNOTE OF HOSPITAL POWER PLANT

By W. H. FISHER
Mechanical Construction Superintendent

The largest engine-generator installation of recent years is that in the power plant of the New York Hospital Medical Center, where three 2,500-hp. uniflow engines supply electricity for hospital uses

EXTENDING along the shores of the East River from 68th to 71st Streets, the New York Hospital Medical Center presents an imposing group of vitrified white brick buildings. The four separate buildings comprising this group occupy 10½ acres of ground and extend back from the river for an entire city block. This most recent addition to the great medical institutions of New York City was built by the New York Hospital-Cornell Medical College Association at a cost of approximately $42,000,000 and opened for reception of patients in September, 1932.

The main hospital building occupies the center of the 68th to 70th Street plot, and rises to a height of approximately 400 ft., although only 28 stories high. The portion of the main buildings facing York Avenue and in the foreground of the picture, Fig. 1, is the Cornell Medical College group. The building at the right is the Psychiatry Building. At the left corner of the group facing west on York Avenue, and running from 70th to 71st Streets, is a 17-story dormitory and hotel with accommodations for 500 nurses.

Electric power for light, elevator service, ventilation, X-ray, and sterilizing, and a myriad of other services, together with steam for cooking and producing hot water, and refrigeration for kitchen service and air conditioning, is all supplied from the power-house building, which extends through from 71st to 70th Streets. Like the other buildings of the hospital, the power-house is finished in vitrified white brick. It is twelve stories high, and has an engine generator room 55 ft. by 180 ft., with a boiler room 50 ft. by 180 ft. at right angles to it, both slightly above grade. The power-house building also contains a 250-car garage, a refrigeration machine room, a laundry (which occupies the second and third floors), carpenter and machine shop equipment (occupying the fourth and fifth floors), and above these individual rooms for employes.

The engine room contains three twin-cylinder, Elliott Ridgway engines, each cylinder being 26 in. in diameter and having a 36-in. stroke. The engines operate at 150 r.p.m. When supplied with steam at 200-lb. pressure, each cylinder develops 1,250 hp., a total output of 2,500 hp. for each of the three engine units, which together occupy a floor space approximately 40 ft. wide by 50 ft. long. Directly connected to each unit is a 1,250-kw., 600-volt, 80 per cent power factor, a.c. generator, and also on the same shaft a d.c. generator of 300-kw. capacity and 250 volts.

Each engine has a Massie centrifugal governor with Rites inertia bars, driven through a lay shaft from the main engine shaft, which also operates the engine valve mechanism. The governor operates an oil relay pilot valve, the power cylinder of which is connected to a linkage mechanism that controls the point of cut-off on both engine cylinders.

As an added safety precaution, an electrically-operated

butterfly valve is installed in the steam line ahead of the main throttle valve. A governor chain driven from the engine shaft is arranged so that an increase in speed of less than 5 r.p.m. will throw out an arm and make an electrical contact. This releases a weighted arm on the butterfly valve, which in closing prevents any further overspeeding of the engine. Engine speed is further controlled by a master Warren Telechron clock system to maintain the constant frequency necessary for the proper operation of electric clocks and other apparatus in the hospital.

Steam is supplied to the engines from a loop header about 30 ft. above the engine room floor. A single connection to this header is made from each engine, with a motor-operated push button control limit-torque throttle valve located immediately after the header connection. After the throttle valve, the line branches to two cylinders, the steam passing through separators attached to the top of the cylinders.

The 16-in. loop header is supported along the window side of the engine room, expansion being taken care of by Yarway sleeve joints in both upper and lower lines.

A 24-in. exhaust header is provided in a special pipe room below the engines, supported on tapered concrete pedestals with roller bearing saddles for the pipe to rest in. Provision has been made in the installation of the exhaust pipe for two additional future engines, for which there is ample space in the engine room. At present, one engine carries the load with another cut in for peak-load periods.

Oil for lubricating these engines is supplied by two 6x4x6-in. duplex pumps, one of which is in reserve. These pumps are located in the basement at the 71st Street side of the building. They give a constant circulation of lubricating oil through two $2\frac{1}{2}$-in. welded pipes which form a loop system, and carry a pressure of approximately 10 lb. The return through a third line is to two large oil storage tanks and filters combined, from which the pumps obtain their supply.

A $\frac{3}{4}$-in. solenoid-operated globe valve is provided in the oil line to each engine. The switch handle controlling this valve is mounted on the engine pilot board at each engine, and is electrically interlocked with the switch on the main throttle valve, so that the oil valve must be open before the engine can be started. A bypass around the solenoid oil valve is provided and included in the electrical interlock, so that if either of the two valves is open the engine throttle valve can be opened. Adjustment of oil supplied to bearings is through the use of sight feeder valves at each bearing. The operation of the solenoid control valve does not interfere with their setting. Thus, considerable time is saved in starting up the engine, and an early supply of oil to all bearings is insured.

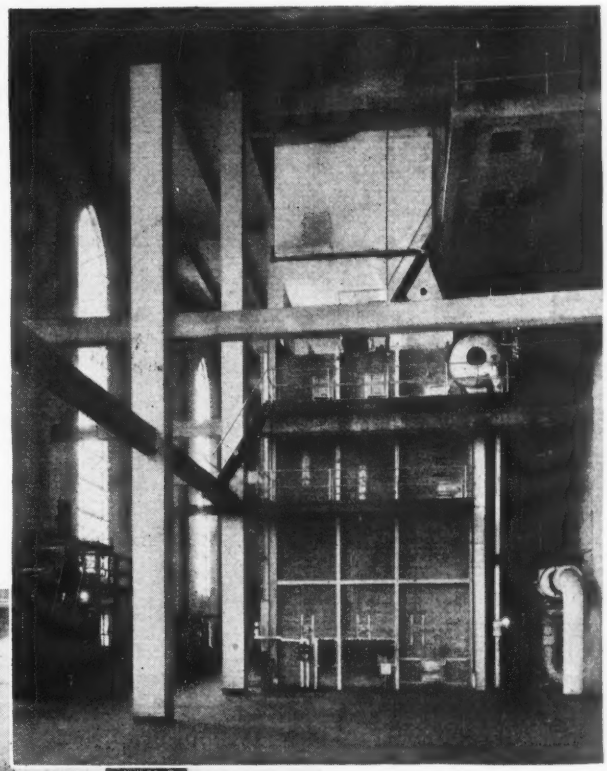

Fig. 3 (Above)—Fuel-oil pumping and heating equipment can be seen at the left and the forced-draft fan at the right just under the ceiling

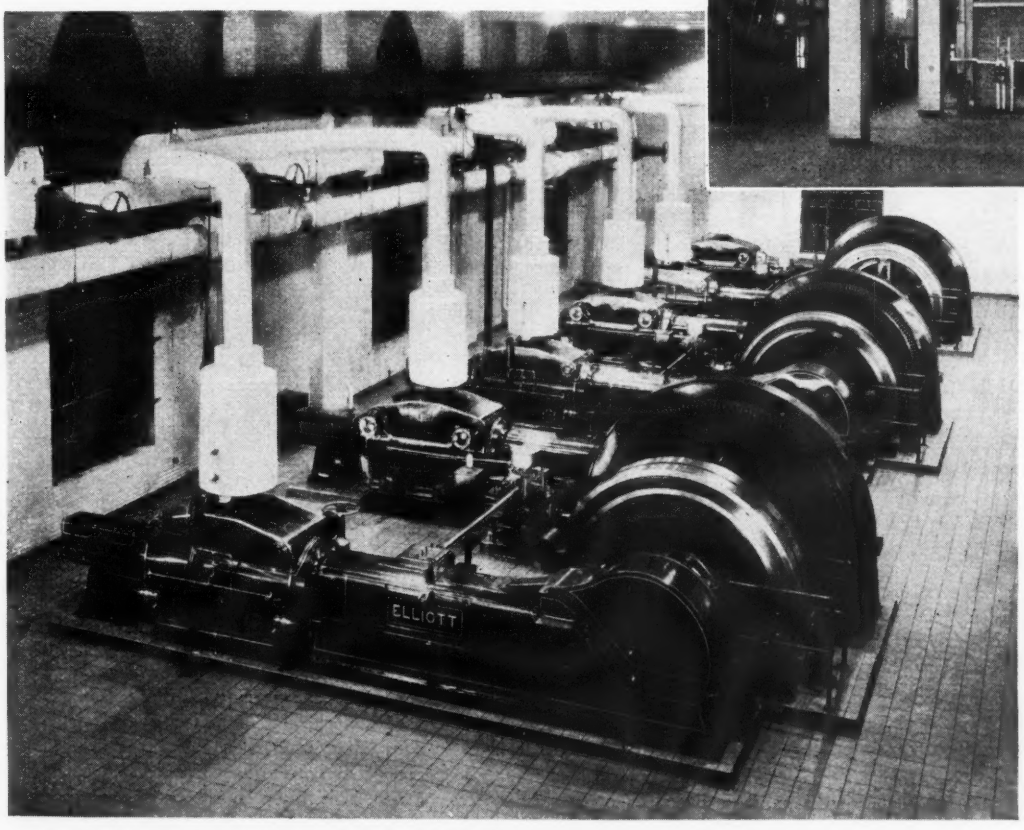

Fig. 2 (Left)—The engine room is finished with vitrified white brick walls and red Dutch tile floors

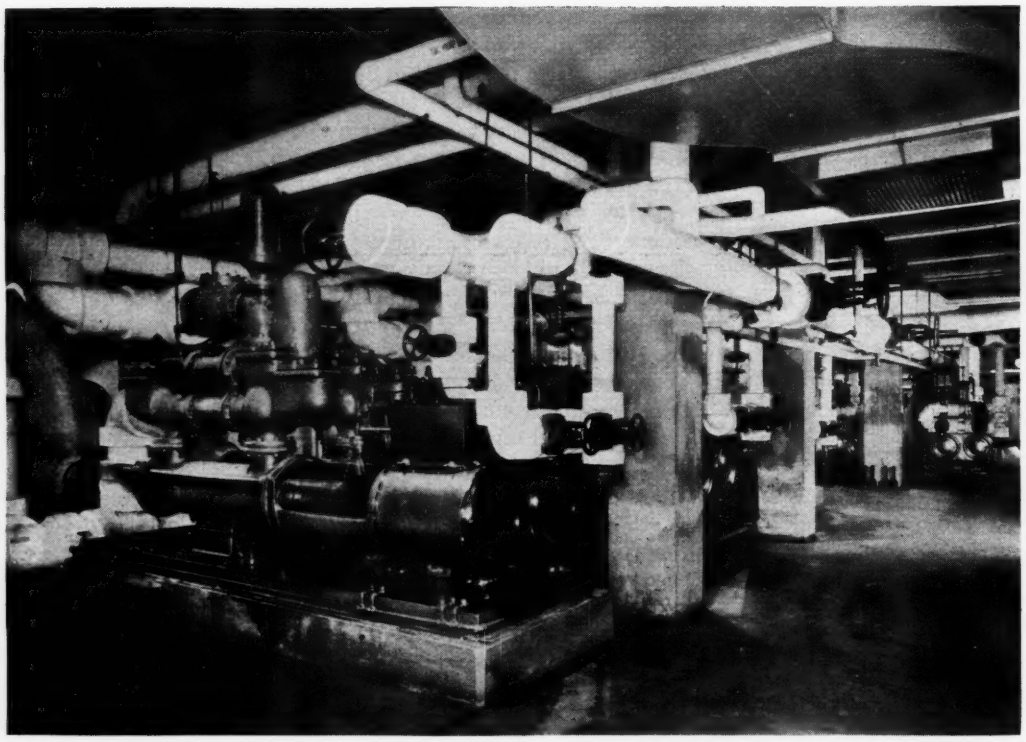

Fig. 4 — In the foreground is one of the 17x10x15-in. duplex feed pumps and in the background are the condensate pumps

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At the northwest corner of the engine room, in a space 20x40 ft., is located a General Electric, bench-type, remote-control switchboard. It is against a slate-back panel on which all the electric recording and indicating instruments are placed. Along the side wall is a steel cabinet-type panel. On this are mounted master recording steam-flow meters, fuel-oil-storage level indicators, and master recording electrical meters.

Under the engine room are located the switches, circuit breakers and transformers, all controlled from the bench-type board in the engine floor. From this room, electric service is governed and distributed.

Dry saturated steam at 200-lb. pressure is supplied by four Walsh & Weidner cross-drum boilers, each containing 8,000 sq.ft. of heating surface. Designed for operation at 200 per cent of rated capacity when burning oil fuel, the boilers are placed 28 ft. above the floor of a refractory furnace.

Five Petro mechanical-atomizing type burners are set in the windbox front of each boiler. These windboxes are 12 in. in depth and 10 ft. high, and are supplied with air from forced-draft fans, through a hollow Dietrich rear furnace wall and a series of vitrified tile pipe built into the floor of the furnace.

The two forced-draft blowers for supplying combustion air are located just under the ceiling of the boiler room on suspended concrete and steel platforms placed at each end of the boiler room. They discharge to the forced-draft duct located just below these platforms along the boiler-room wall. The 75-hp. d.c. motors driving these fans are controlled by automatic combustion control through a gang rheostat in the field circuit. This has 43 steps and gives a speed range of 470 to 940 r.p.m.

Manual or automatic control of the fans may be obtained from either the master or individual control panels in the boiler room. These fans have not been found necessary, and the boilers operate on natural draft.

Six fuel-oil storage tanks, with a total capacity of 136,600 gal., are encased in a concrete vault at the basement level of the boiler room under a service entrance between the power-house and the nurses' residence on the 71st Street side. Fuel oil is normally received by barge. The barge delivery pipes are connected to a 10-in. underground welded extra-heavy steel pipe, which leads directly to the oil storage tanks through a double-valve manifold in the pipe gallery in front of the fuel oil vault. Separate tank connections are installed at the curb so that, in case of emergency, oil can be delivered by truck. The 10-in. line is completely encased in reinforced concrete and has a 1½-in. steam line running through its full length, with a condensation trap at the river end. Here a concrete vault is provided for the control valves and connecting flange.

Telephone connection is maintained between the vaults and the oil gallery while oil is being delivered by boat each week. The quantity of oil is determined by several meters, one set at the gallery, one set at the master control panel in the boiler room, and another at the master control panel in the switchboard room.

Oil is received at a temperature of about 120 deg., and is maintained at about that temperature during delivery and while in the storage tank by use of a hot-water heating system. This is a separate hot-water system, having its own two generators and two 6x4x6-in. duplex steam pumps for circulating the hot water located outside of the oil gallery.

Fuel oil is pumped from the storage tanks by one of two 7½x5x10-in. duplex steam-driven pumps placed in the boiler room on tiled concrete bases, through two 6-in. welded-steel suction pipes. On the suction side of the pump are twin-basket oil strainers cross-connected and valved, so that a double loop system of oil supply is available at all times. On leaving the pump, the oil passes through twin-basket strainers and two vertical steam heaters, which raise its temperature to 230 deg. before passing through additional strainers to a 3-in. welded extra-heavy steel boiler fuel header.

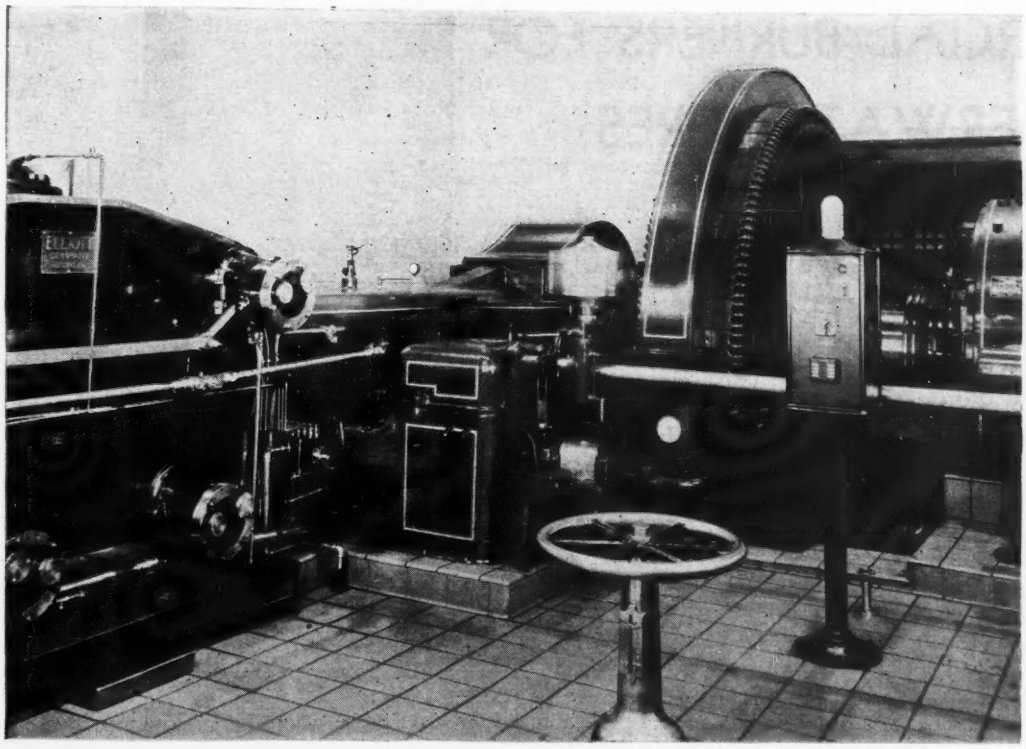


Fig. 5 — The engines are governed by a centrifugal governor acting through an oil relay

Oil pressure is carried at approximatley 250 lb., and the supply to each boiler is controlled through 1½-in. motor-operated chronometer valves. These are controlled by the combustion control equipment.

The Leeds & Northrup electric combustion control equipment is arranged so that a master control current is varied in response to changes in steam demand. The metered rates of fuel and air supply are balanced against the master current.

Regulation of the master current is effected through the use of a master controller responsive to header steam pressure. Air-flow at each boiler is held in constant ratio to the control current by an air flow controller acting on the uptake damper.

Acting in conjunction with this draft control, a furnace pressure controller regulates the forced-draft damper to maintain constant pressure in the furnace. A fuel-feed controller operates in a manner similar to the air-flow controller to maintain a definite relation between the control current and the position of the fuel-oil chronometer valve. The oil control valve is readjusted as required in response to a fuel compensator which measures the CO_2 content of the flue gas. Selector switches at each boiler control panel compensate for different numbers of oil burners in operation. A forced-draft pressure controller operates in a manner similar to the furnace pressure controller and maintains constant pressure in the common forced-draft duct.

Located in the center of the power-house building on the central axis of the general group is the boiler stack rising 410 ft. above grade. A rectangular steel tower, to the full height of the stack, was built and inclosed with vitrified white brick. The stack proper, 14 ft. inside diameter, of hard-burned radial brick, was built inside of the rectangular tower. The top of the stack has been mounted with a manganese steel coping 2 ft. higher than the brick work. As the outside steel and brick work is square and the stack is round, there is space in each corner for ventilation and pipe shafts.

The 18-in. atmospheric exhaust pipe is placed in one of these corners and carried to the top of the stack, terminating in an exhaust head. The steel breeching from the boilers enters the smokestack about 7 ft. above the sixth-story level.

The base of the steel tower terminates in the sub-sub-basement and is inclosed with brick on three sides, with a large steel door on the side facing the boiler feed pumps. This door is usually left open, and the strong updraft from the corners of the tower provides ventilation for this portion of the sub-sub-basement.

Condensate from all buildings is returned to two 1,500-gal. steel asbestos-covered tanks. Two 14x10¼x12-in. duplex steam pumps draw water from these tanks and deliver it to two Cochrane exhaust heaters and deaerators, into which make-up water is added as needed. From the heaters the water passes through a V-notch meter and then to the boiler feed suction header. Three Worthington feed pumps are located in the sub-sub-basement. Two of these pumps are 17x10x15-in. duplex outside packed plunger pumps; the third is a 12x7¼x15-in. pump of the same type. Only one of these pumps is required for service, the others being held in reserve.

The boilers have been operated at above 200 per cent of their normal rating. Normal operation of these boilers during the month of December required the consumption of approximately 10,000 gal. of fuel oil per day. Steam production averaged better than 1,200,000 lb. per day, with an average evaporation of 14.76 lb. of water per pound of fuel. Daily electric energy generated averages about 24,000 kw.hr., the average load being about 580 kw. on the a.c. generators and 350 kw. on the d.c. generators.

Power acknowledges the courtesy of W. W. Downey, director of engineering and maintenance, and L. G. Tooker, chief engineer, for releasing this article for publication. The hospital project was designed by Coolidge-Shipley-Bullfinch-Abott Co. of Boston.

COMMERCIAL BURNERS FOR UNDERWATER FIRES

By KENNETH A. KOBE and CARL W. HAUGE
University of Washington

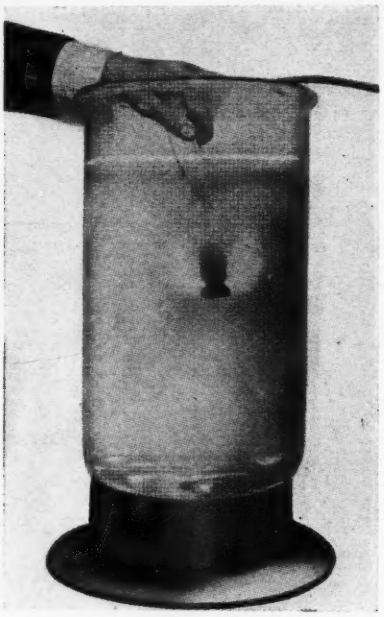
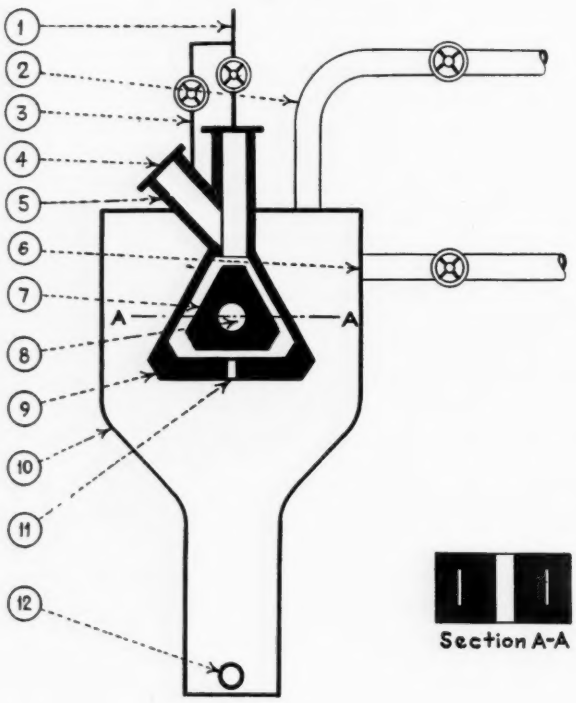


Fig. 1—Submerged combustion with Kemp burner

Submerged combustion offers an opportunity to combine low equipment costs with high efficiency in transfer of heat from burning fuel to liquid. Here are described features of burners now available

TRANSFER of heat from gases to liquids was first carried out by separating the two fluids with a wall through which the heat had to pass. Although this method gave rise to many difficulties of operation, the same principle has been retained throughout the many advances that have taken place. The steam boiler, despite its many improvements, still transfers the heat from the products of combustion to a metal wall which in turn conducts the heat to the liquid. If the metal wall were eliminated and the heat transferred directly from gas to liquid, many difficulties would be obviated. Submerged combustion carries out the combustion within the liquid so that all of the heat is transferred to the liquid by the gas formed in it. This eliminates an outside chamber for combustion and a metal wall through which heat must pass. It also prevents loss of heat in the products of combustion.

Fig. 2—Water level must be below opening 11 when starting Brunler burner



The many efforts made since the first patent in 1887 show the struggle to discover all of the necessary conditions for submerged combustion. Failure to employ all of these principles accounts for failure in operation.

Essential elements of the burner in which combustion takes place below the surface of the liquid are:

1. A mixing chamber from which a homogeneous mixture of air and fuel will result. The air and fuel must be delivered at a pressure above the boiler pressure. It is apparent that a gaseous fuel is most satisfactory; however, oil is also successfully used. Due to the intimate mixing, little or no excess air is needed for complete combustion.

2. A velocity tube through which the fuel-air mixture passes to the burner at a rate greater than the rate of flame propagation of the combustible mixture. This prevents the burner from backfiring into the mixing chamber.

3. The burner usually contains a refractory surface which becomes incandescent, thus acting as an ignition point for the fuel-air mixture and insuring its complete combustion. The construction must allow heat to flow away from the incandescent surface fast enough so that the refractory will not fuse, yet not so fast that it will cool below temperature which will keep fuel ignited.

Brunler Boiler

In 1887, Oscar Brunler started work on submerged combustion, but it was not until 1913 that he was able to make a commercial installation which, however, was destroyed during the war. Oscar Brunler, Jr., took up the work after his father's death and has evolved an oil-burning boiler used for steam generation and also for solution evaporation. Combustion takes place in the steam generator, shown diagrammatically in Fig. 2, which is connected to the boiler body. The generator (10) is fitted with a burner of cast steel (9) which receives the oil-air mixture from pipe (1) or its bypass (3). On the upper side of the generator is a tube-like part (5) provided with a removable metal cover (4), both lined with refractory. The central portion of the burner contains a bridge (7) having a hole (8)

open to the water in the generator. Around the bridge are passes which have a common outlet (11) from which the flame issues into the water. A drain or cleaning hole (12) is at the bottom for the removal of sludge. Oil and air necessary for the combustion are supplied to the burner at a pressure slightly above that of the steam.

Before starting, the water level in the generator must not be above opening (11). The cover is removed and the refractory lining of (5) heated to redness with an auxiliary torch, then the cover is replaced. Oil and air admitted through the bypass ignite and soon heat the bridge (7) so that it will ignite the oil and air mixture. The connecting valve in the line (6) to the water reservoir is now opened and the water level allowed to rise up to the middle of the burner; it must not rise too high or the bridge will cool below the point where it will ignite the fuel, nor can the water level be too low or the bridge will overheat and fuse away. The steam-gas mixture passes back to the reservoir through line (2).

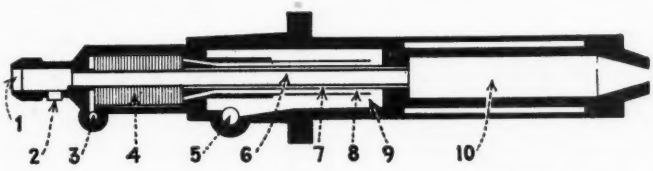


Fig. 3—Hammond burners for submerged combustion of gas deliver from 30,000 to 1,000,000 B.t.u. per hr.

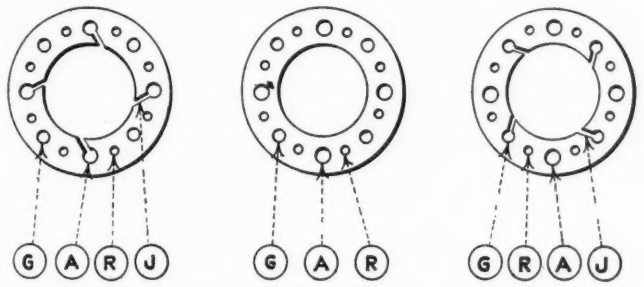


Fig. 4—Air-gas mixing disks for Hammond burner

A burner for gaseous fuels has been developed by C. F. Hammond, who has promoted commercial development of the apparatus along several lines. The burner, shown diagrammatically in Fig. 3, has compressed air entering at (5) to the outer chamber (9) and up to the inner air passage (8) to the air-gas mixing disks (4). Compressed fuel gas enters at (3), passing directly into the mixing disks, whose construction is shown in detail in Fig. 4. The disks are drilled for air passages (A), gas passages (G) and joining rods (R). The air and gas passages are connected to the central mixing chamber by jets (J), whose cross-sectional areas are such that the gas and air have approximately the same velocities so that the two streams diffuse into one another to give a homogeneous mixture. This mixture passes down through the velocity tube (7) to the combustion chamber (10), which is lined with an alundum refractory. The combustion is started at the ignition connection (2) and the progress can be viewed through the glass window (1) at the upper end of the flame sight tube (6).

Cooling of the burner to prevent the upward creep of heat is accomplished by circulation of air through passages (8) and (9) and of the air-gas down through the velocity tube (7). A spring system (not shown) prevents mechanical stress on the joints due to expansion when the burner is heating.

The commercial burners are constructed in sizes to deliver from 30,000 to 1,000,000 B.t.u. per hr.

Kemp Burner

Development work in this country has produced a submerged combustion burner using gaseous fuel. The gas and air, mixed in a Kemp industrial carburetor in the proper ratio for complete combustion, pass through a back-fire preventor located outside the building and then into the distributing main that supplies the burners. A fire check is placed in the line between the burner and the distributing main.

The burner shown in Fig. 5 is made in one size $1\frac{7}{8}$x$3\frac{1}{2}$ in. and threads onto a $\frac{3}{4}$-in. pipe. It will supply from 30,000 to 38,000 B.t.u. per hr., depending on the kind of gas used for fuel. The burner shell usually is of cast iron, but Duriron is also used for corrosive solutions; the inner disk is of refractory material.

Gaseous Products

Since the combustion occurs within the body of the liquid, the products of combustion and the steam produced will leave together. Thus water vapor, carbon dioxide, oxygen and nitrogen are the gaseous products which all leave the boiler together. In this mixture the molecules of each component gas are uniformly distributed throughout the entire volume. Each component gas will contribute a definite fraction of the total pressure; this part of the total pressure contributed by any one component gas is called its partial pressure. The total pressure is the sum of all the partial pressures.

If partial pressures of the carbon dioxide, oxygen and nitrogen are added together the sum may be called the partial pressure of the combustion products. If evaporation takes place at atmospheric pressure it is apparent that the partial pressure of either the water vapor or the combustion products will be less than one atmosphere, since their sum must equal the pressure at which evaporation is occurring. The water in the liquid and vapor states must be in equilibrium, so that vapor pressure of the liquid water must be less than one atmosphere and its corresponding temperature below 212 deg. F. This is equivalent to having a vacuum in the system.

Thus submerged combustion is a method whereby the

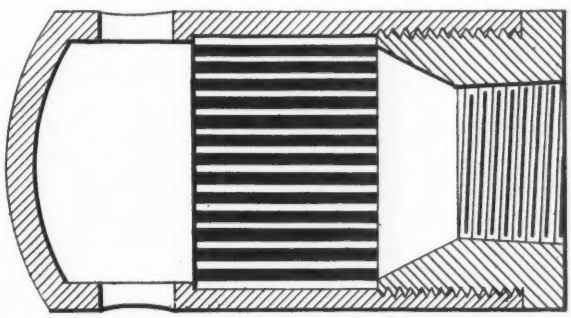


Fig. 5—Air and gas are mixed in a carburetor ahead of the Kemp burner

equivalent of vacuum evaporation is carried out at atmospheric pressure. Whatever the boiler pressure, the temperature of the water will correspond to a lower pressure—that is, the partial pressure of the water vapor.

[Numerous applications of submerged combustion will be given in a future article.—Editor.]

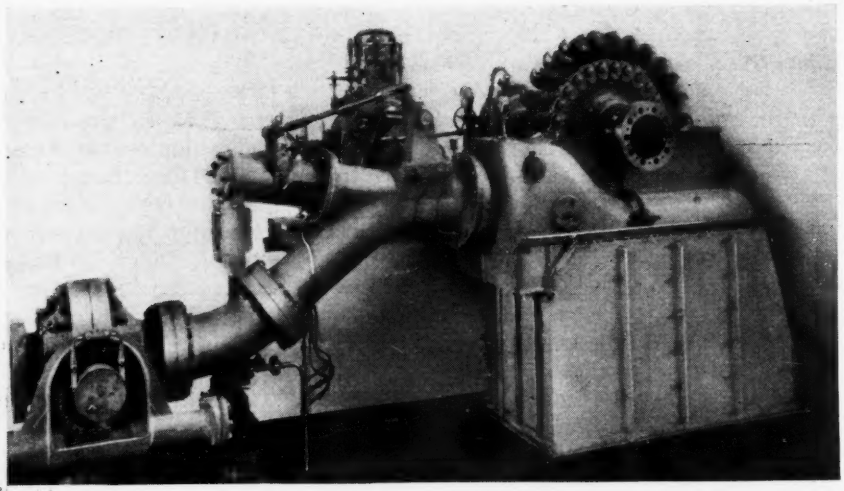


Fig. 1—One of the two 11,450-hp. impulse wheels that operate under a 3,280-ft. head

TWO 11,450-Hp. IMPULSE WHEELS Operate Under 3,280-Ft. Head

THE wheels in the Niederenbach hydro-electric station, in Switzerland, operate under a net head of 3,280 ft., next to the highest that has been utilized. The total static head is 3,560 ft. There are two units, each rated at 11,450 hp., which operate at 750 r.p.m., and drive an 11,000-kva., 8,800-volt generator. Each turbine has only one bearing, and directly couples to a two-bearing generator. The photograph shows the coupling side of the wheel.

Each wheel has 26 buckets machined to fit astride the cast-steel disk to which they are bolted. A feature in the construction of these wheels is use of two different kinds of high-quality material for the buckets. Different materials are also used for the various parts of the nozzles that are subjected to high-pressure water. This has been done to find out what kind of material has the best wearing qualities for these services.

Speed control is obtained by a regulator that acts directly on the jet to deflect it off the buckets, after which the needle closes to a position corresponding to the load on the unit and the deflector returns to normal operating position. Needle position is controlled by two cylinders, one for opening, in which there is penstock pressure, and one for closing the needle. The piston in the latter cylinder is acted on by pressure oil. With this arrangement, if the oil pressure fails the unit is safely shut down.

Should the wheel overspeed, a safety device operates to release the oil pressure in the regulator cylinders, and the unit is shut down automatically. This safety device also closes a switch that energizes a solenoid on a 15.75-in. ball control valve in the penstock and causes this valve to close slowly. Thus two means are provided to prevent the machine from running away. A braking nozzle is provided to bring the unit to rest quickly.

The curves show the guaranteed and acceptance-test efficiencies. A maximum efficiency of about 89 per cent was obtained on test. It is stated by the waterwheel manufacturers, Escher-Wyss Engineering Works, Ltd., that the water to these wheels, when on acceptance tests, was measured by a weir and calibrated nozzle. The water quantities, as measured over the weir, were calculated by the formula of the Swiss Engineers and Architects Association. Before the tests were made the various velocities in the weir channel were accurately checked by current meters and corrected by installing

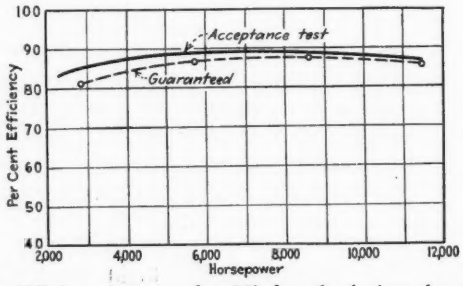
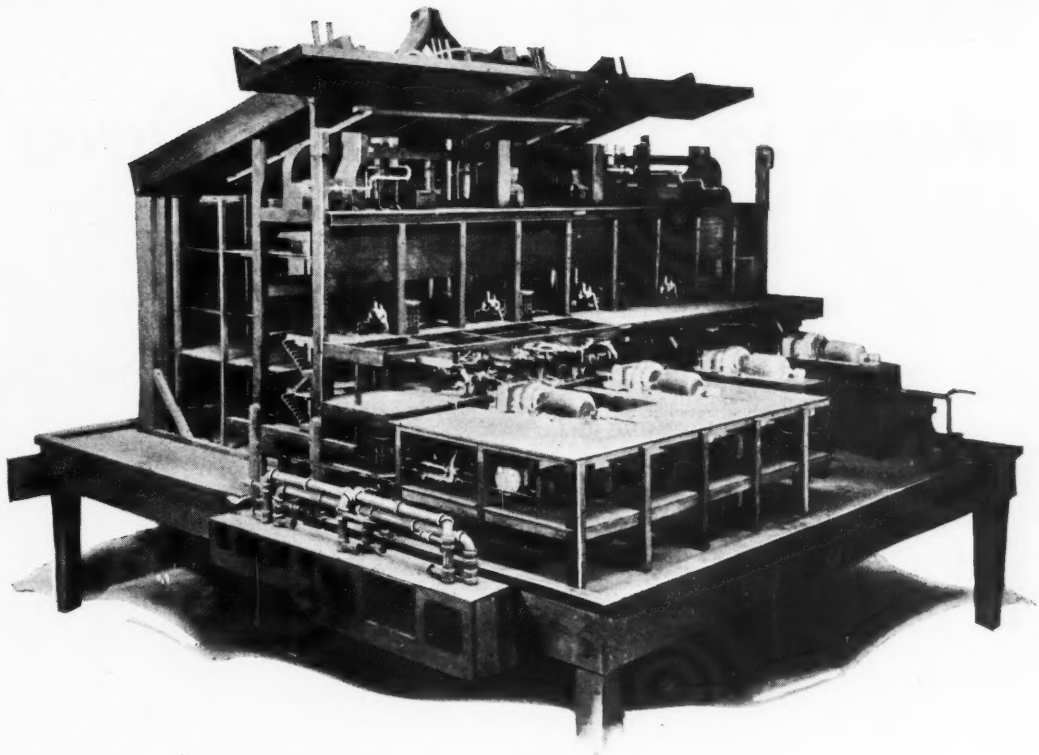


Fig. 2—Efficiency curves for Niederenbach impulse wheels

suitable devices for quieting the water until the velocities of the latter correspond to the requirements of the weir formula.

As a further check, the quantity of water was measured by the needle nozzle, which had been previously calibrated in the laboratory. The agreement was very good between the quantity of water as measured by the weir and that obtained by means of the nozzle.

The only wheels operating under a higher head than those in Niederenbach plant are the three in the Fully plant, Switzerland. These are each rated at 3,000 hp., and operate under a 5,350-ft. head.



Power Plant Models Pay Dividends

TWO men appreciate the endless time, trouble and skill expended in the construction of a scale model of a complex plant—the model maker and the man who pays the bill. Such models are works of fine art, a delight to the eye, immensely educational. Some of them have been, and always will be, made purely as an outlet for man's creative instinct.

These motives, however, cannot often be primary in the construction of elaborate plant models. In most cases the model must pay out in cold cash. It must be cheaper to build the plant plus the model than to build the plant alone, and, strange to say, it usually is, when one considers the resulting simplification of the job of designer and erector.

Theoretically, elevation and plan drawings, with cross-sections, tell the whole story of plant elements and their positions. Actually such drawings are hard to visualize, particularly where there is a maze of piping and duct-work. Pipes and ducts that seem clear on the drawings are found to interfere after erection starts. With full-scale equipment correction of such errors is very costly. It is far cheaper to make and correct the same mistakes in miniature.

A special room in Detroit's recently completed monumental Springwells pumping station is devoted to the elaborate model, here shown, of its steam-electric power plant. A pre-construction story of this remarkable plant appeared in the March 24, 1931, number of *Power* and an early number will present photographs and further description of the completed job.

W. C. Rudd (Assistant Engineer, Power Division of Water Supply, City of Detroit) and his colleague, A. C. Michael, have supplied the following comments regarding the practical value of models such as this:

"The power plant piping system model, which is stored here in the plant, of course served its most useful purpose during the design of the power plant, but it has other advantages which should not be overlooked.

"During design it is almost impossible to visualize clearances and arrangements of piping, so complicated does such a system become. The model, if it is constructed as the design progresses, is of inestimable value as a time saver and to enable the designer to more easily visualize the whole system at a glance. This results in elimination of interferences during construction and a better general design.

"During construction the model aids materially in reading complicated drawings and allows visualization of pipe systems with respect to other systems which go to make up a complete plant piping system. Clearances are shown very clearly and errors in fabrication and erection can be seen immediately upon inspection of the model.

"The greatest advantage of a model is that it places the whole system before the eye and eliminates the necessity of tracing lines through the whole plant. During operation if for any reason the route of any system is required it is only necessary to look at the model for a determination. It is useful also in educating new operators and in computations involving records and charts."

HOW TO SELECT THE PROPER

Motors for Ventilating-Fan Drives

By C. P. HAMILTON
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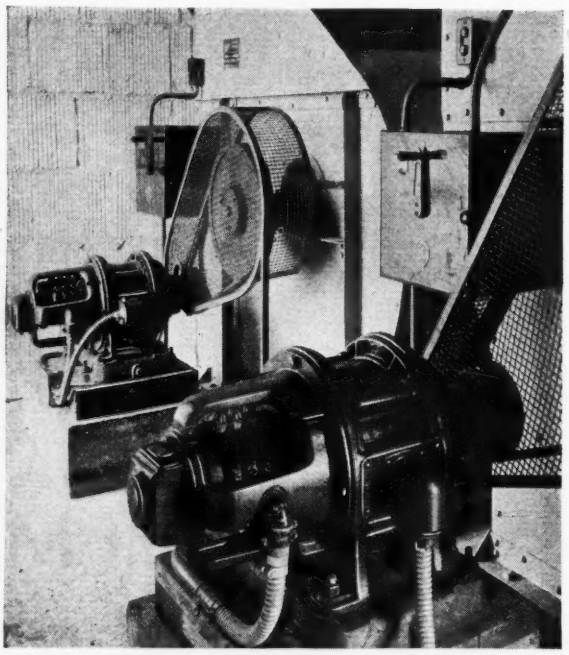
What motor type is best suited for a particular fan installation? Application of motors to ventilating-fan drives on the basis of their adaptability to speed control, relative cost, power consumption and quietness

MANY fan installations operate at constant speed. For such applications either a single-speed alternating-current induction or direct-current motor is used, depending upon the power supply available. There are, however, many installations which require adjustment of the fan speed. Ventilating engineers are then confronted with selecting a motor that will provide the desired driving speeds.

Before a motor is selected the probable operating speed range should be decided upon. This is particularly true of direct-current motors, since single-speed motors of this type are often good for 25 per cent speed variation by field control. While it is general practice to use a speed range down to 50 per cent of full speed for fans, the necessity of such a broad range is open to question.

When definite reduced speeds can be used, such as 75, 60 and 50 per cent of full speed, the multi-speed squirrel-cage motor offers a possibility, particularly for installations requiring considerable power. Operating characteristics of this type of motor are shown in Fig. 1. The efficiency of this motor is particularly good at reduced as well as at high speeds, while the power factor falls off rapidly below 75 per cent speed.

Variable-speed operation can also be obtained with a single-speed, high-slip, squirrel-cage motor. An infinite number of speeds are possible, down to about 50 per cent of no-load value, with suitable equipment to vary the voltages. Theoretically, such a motor can be built for any horsepower rating. However, as the horsepower per pole is increased, it becomes more difficult to dissipate the heat when the motor is running at slow speed, making necessary large frame sizes or special construction. It is also more difficult to keep high-speed motors cool than the slow-speed type, because of a rising current characteristic as the speed is reduced, being as high as 115 per cent of full-load value at about 75 per cent speed in some cases. The cost of such a motor is only justified in the smaller sizes, as it has no advantage over a slip-ring motor of equal cost. For the two types of motors with control, the average cost curves cross between 5 and 10 hp. in favor of wound-rotor construction.



Wound-rotor motors, with secondary-resistance speed control, drive building-ventilating fans

There is very little difference when operating at partial speed in the efficiency of the two types of motor, because resistance is used in the rotor circuit of each to obtain reduced speed. When operating at full speed, the wound-rotor motor is the more efficient because of the higher rotor loss of the high-slip motor. High-slip, squirrel-cage motors are generally confined to fans requiring not over 5 hp. and where efficiency is secondary compared to initial cost.

Methods of controlling the voltage for high-slip motors are primary resistance, primary reactance and transformers with taps. The first method is flexible, as a large number of adjustments can be obtained by changing taps on the resistor unit. On the other hand, the reactor may be more or less flexible, depending on its construction. For example, the movable core type or equivalent provides an infinite number of voltages within its limits. Voltage control by a simple core and coil reactor with taps is limited by the number of taps provided. Starting torque of a motor with either the resistance or the reactor method of voltage control is low, particularly at 50 per cent full speed. Starting current of an induction motor varies directly with the voltage and the torque as the square of the voltage. The starting voltage will be lower than necessary to produce the required speed. The starting current being higher than the running current will cause a voltage drop across the reactor or resistor correspondingly higher.

As pointed out previously, some high-resistance type motors, particularly the 4- and 6-pole designs, may have a rising-current characteristic as the speed is reduced. Therefore, with either resistance or reactance to reduce the voltage, it is possible that the motor will stall when operating at slow speed. Since a transformer maintains practically constant voltage from the start of the motor to the normal running speed, it largely avoids the possibility of stalling the motor during starting.

With either resistance or reactance control, motor operation tends to approach instability as the speed is reduced to 50 per cent, because its characteristic then tends to coincide with the fan characteristic curve, as in Fig. 2. When this type of motor is applied to a belted fan, which requires more starting torque than a direct-connected drive, it is preferable to apply full voltage during starting, particularly when automatic control is used.

Wound-Rotor Type Induction Motor

Wound-rotor induction motors are extensively applied for variable-speed service, using secondary-resistance

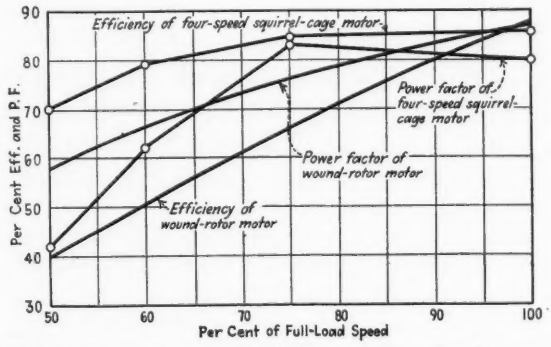


Fig. 1—Power-factor and efficiency curves of a four-speed squirrel-cage and a wound-rotor motor driving fans

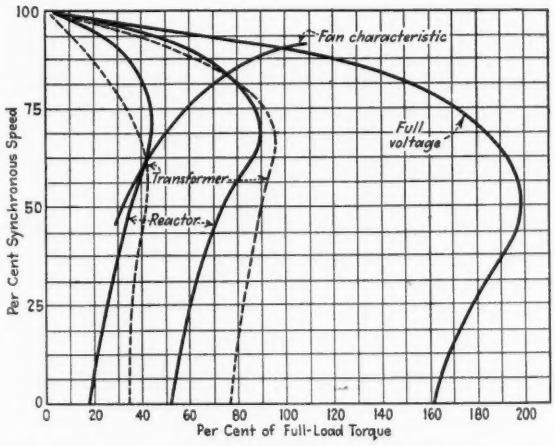


Fig. 2—Characteristic curves of a high-slip squirrel-cage motor with reactor and transformer-voltage speed control

control. The efficiency and power-factor characteristics of this type of motor are included in Fig. 1. When starting torque is considered, a wound-rotor motor is preferable to a high-slip, squirrel-cage type. As resistance is inserted in the rotor the starting torque increases, until the maximum torque is obtained at start. Then the resistance is reduced to give about 50 per cent torque for a 50 per cent speed reduction, as shown in Fig. 3. As previously mentioned, the starting torque of the high-slip, squirrel cage motor, on the other hand, is greatly reduced when reduced voltage is applied to obtain slow speed.

Because of the favorable starting-torque characteristics of the wound-rotor motor, it will bring a fan to operating speed in a much shorter time than will a high-slip, squirrel-cage motor. Another favorable characteristic of the wound-rotor motor is its stability of operation at reduced speed. This will be seen in Fig. 3; the fan curve intersects the motor curves at wide angles. Flexibility in speed control with this type motor is limited only by the design of the secondary rheostat and the number of steps provided in the controller.

Brush-Shifting Type Motor

A brush-shifting type, alternating-current motor has practically an infinite number of speed positions within its operating range. It has high starting torque on all positions of the brushes, and its efficiency remains nearly constant over the operating range. High initial cost is the principal objection to this motor. With control, the cost is approximately twice that of a wound-rotor type of corresponding rating. Its advantage of high slow-speed efficiency is a secondary consideration, since the power required by a fan decreases about as the cube of the speed. The flexible control that can be had with this type of motor without auxiliary equipment justifies giving it careful consideration for many installations.

There are other means of obtaining speed control of alternating-current motors, but the complications and expense involved are not justified when considered for application within the scope of this article.

Direct-Current Motors

With direct-current there are three possibilities of speed control: A constant-speed, shunt-wound motor using armature-resistance control; an adjustable-speed motor with shunt-field control; and an adjustable-speed motor designed for speed variation by field control for part of the range, and armature resistance to obtain a further speed reduction.

Fig. 3—Speed-torque curves of wound-rotor motor compared to fan-load characteristic

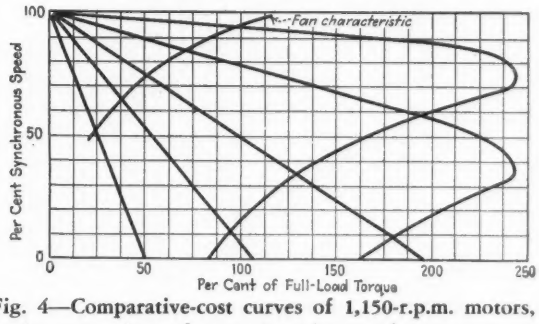
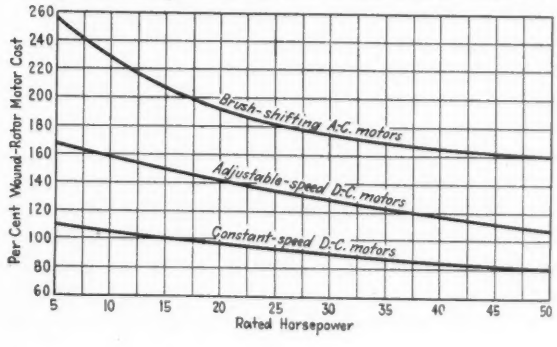


Fig. 4—Comparative-cost curves of 1,150-r.p.m. motors, using manual speed control, with wound-rotor motors



Selection from these possibilities is primarily one of economics. A constant-speed motor with armature-resistance control is the least expensive to install, but has the lowest efficiency at reduced speed. For fans that operate at full speed most of the time, this type of motor and control is justified. An adjustable-speed motor with field control over the speed range desired, while higher in first cost, has a better efficiency at reduced speed than a constant-speed motor. It is therefore preferred for fans that operate at slow speeds most of the time.

For fan installations where the speed range is between 100 and 65 per cent of full speed, that operate only occasionally at low speeds, field control of the speed to about 70 per cent and armature control for the lower range will often be the least expensive.

Curves, Figs. 4 and 5, show the relative costs of different types of motors based on the cost of wound-rotor motors with control of the same rating. Since these curves were prepared for 5-hp. motors and larger, they do not include high-slip, squirrel-cage motors, which are not economical above that rating.

On the basis of yearly operation of a 40-hp. motor running 10 per cent of the time at 100 per cent speed, 30 per cent of the time at 75 per cent speed, 20 per cent of the time at 60 per cent speed, and 10 per cent of the time at 50 per cent speed, the power consumption of the different types of motors is as follows:

	Kw.-hr. per year
Four-speed squirrel-cage motor	90,300
Wound-rotor motor	113,600
Brush-shifting motor	106,300
Direct-current constant-speed motor	109,700
Direct-current adjustable-speed motor with field control	92,900
Direct-current adjustable-speed motor with field and armature control	92,400

The four-speed, squirrel-cage motor is the most economical, but it has only four definite speeds and has not as flexible a speed range as the other motors and control. Since the duty cycle requires operation most of the time at partial speed, it is necessary to use resistance to obtain reduced speed with wound-rotor motors and with direct-current, constant-speed motors, consequently the power consumption of these two types is considerably higher than the others.

It is becoming more important each year to use quiet-operating equipment for many fan installations. This is particularly true in modern office buildings, hospitals and schools. Motor manufacturers, in general, have met this requirement. There seems to be an idea that a motor can be made noiseless. The fundamental characteristics of a motor, particularly the alternating-current type, make it a vibrating machine because of its pulsating flux, therefore it has the elements of a noise producer. These effects are very largely eliminated by proper design and construction, so that the noise level of the so-called quiet-operating motor has been reduced to a point at which it is acceptable for critical installations. It seems that motor designers have about reached the limit in noise reduction of commercial motors. Recognizing this, architects also lay stress on the design of foundations with proper sound insulation. There still exists the need of a general specification of acceptable noise levels for motors on which all motor manufacturers can base a performance guarantee.

It is first desirable to distinguish between air-borne noises and those that are transmitted through the foundation of the building structure. Air-borne noise characteristics are largely the result of high-frequency vibrations produced by windage of high-speed motors and, in

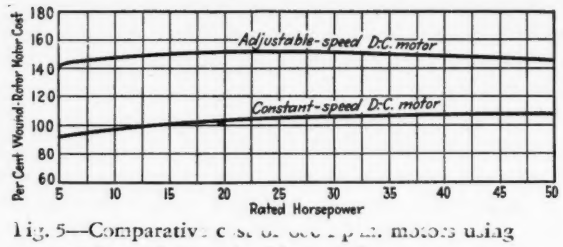


Fig. 5—Comparative cost of adjustable-speed motors using manual speed control with wound rotor motors

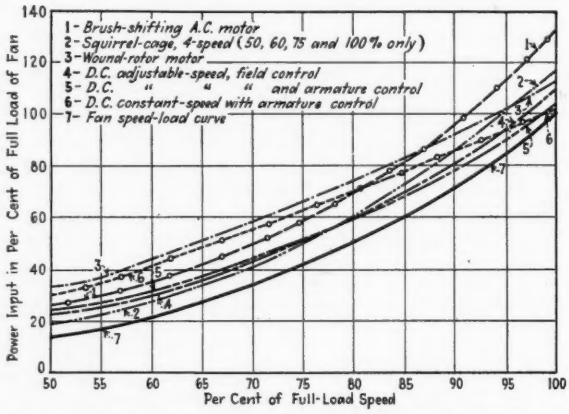


Fig. 6—Relative power consumption of various types of motors based on full-load input to fan

many cases, by the brushes. Such noises are usually isolated to the room in which the motors operate and are not transmitted through the walls or foundation. Low-frequency vibration, in the order of 200 cycles per second and below, must be guarded against being transmitted to the building by a foundation for the motor that will dampen out these frequencies. All motors, particularly alternating-current types, are subject to some degree of low-frequency vibration depending on the effectiveness of the design.

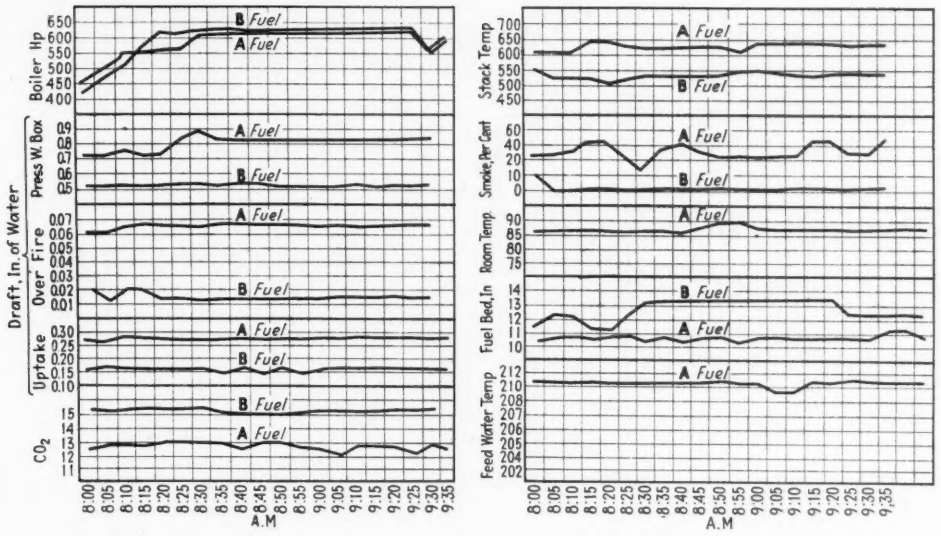
Air-borne noises due to windage may be largely avoided by using motors operating at 1,200 r.p.m. and below. Brush noises are usually not so troublesome, but can be greatly reduced by proper design of the holders and by the angle of brush contact.

It is more difficult to design quiet, slow-speed, alternating-current motors than the higher-speed types, because of the less latitude that the designer has in the selection of slot ratios, due to the larger number of poles. Therefore, the quieter induction motors are usually of 6- and 8-pole designs. When direct-current motors are applied, the reverse is true, as slow-speed motors have a lower noise level than high-speed types.

Smog Doggerel

Year after year we've heard these words spoke,
Educate people and you'll have no dense smoke—
But all the sweet phrases this side o' Hell
Won't catch any cinders, won't wash out the smell.
If you want cleaner air, stop the smoke and dirt shower;
Pass the right kind of law, then enforce it with power.

These at least are the sentiments of H. W. Evans, member of the Advisory Board of Engineers of the Smoke Prevention Association of Chicago. It is his honest opinion of the smoke abatement situation—an opinion with which many others interested agree.



Graphic log of test establishes "best" conditions which are tabulated or plotted on separate sheet to guide fireman in daily operation.

Charting BOILER OPERATION Saves Coal

By L. A. CORWIN
Chief Engineer, Milwaukee Chair Company

IT IS one thing to install a boiler plant guaranteed to give high efficiency with a given fuel. It is quite another to maintain good efficiency in daily operation while taking full advantage of coal bargains made available by the particular plant location and frequent shifts in relative coal prices. Each new coal tried requires experimentation with drafts, fuel-bed thickness, etc., to determine the combinations that will give the highest efficiency consistent with low furnace maintenance and freedom from clinker troubles, slagging and burned out grates. These best conditions must be determined for each rating.

The real problem arises when this preliminary experimentation has been completed. How can the knowledge so gained be transferred to the fireman who is expected to get the most out of this fuel, day after day under continually changing conditions?

The most practical answer, according to my experience, is a chart posted near the boilers for the guidance of the fireman. For the given boiler and fuel, and for all ratings, this should show instantly the proper CO_2, stack temperature, windbox pressure, overfire draft, uptake draft and thickness of fire.

Such a working chart assumes the installation of a complete set of indicating or recording boiler instruments for use both in the preliminary tests and in daily operation. It also requires a graphic log of the test data as a basis for constructing the operating chart.

The accompanying chart is an example of a graphic log, plotted on standard cross-section paper. Two different operating tests, with two different fuels marked "A" and "B," are plotted. Data included are: Boiler load on steam flow meters; wind-box pressure, inches of water; over-fire draft, inches of water; draft at uptake, inches of water; thickness of fuel bed, inches; CO_2 recorded, per cent; stack temperature, deg. F.; per cent smoke (Ringleman chart); room temperature, deg. F.; feed-water temperature, deg. F.

The graphs are arranged one above the other on the same time scale, with vertical lines at 5-min. intervals. The test, and the corresponding graphs, should be continued for at least four hours.

The example given clearly shows the superiority of fuel "B" in maintaining efficiency, as indicated by high CO_2 and low flue temperature. This, of course, may be outbalanced by lower cost of fuel "A."

The operating chart for guidance of the fireman may be made up of a series of curves showing the correct boiler conditions for all ratings, one curve for each element listed. Since, however, many firemen will have difficulty reading such curves, it is generally more practicable to prepare the operation chart in the form of a simple table.

Such a table for fuel "B" and 630-hp. rating, would read about as follows:

Fuel B

Rating	630-hp.
Thickness of fire	13
Windbox pressure	0.5
Over-fire draft	0.02
Up-take draft	0.15
CO_2	.15
Stack temperature	530

With this fuel and rating, and operating with the indicated conditions, the fireman should be able to maintain the listed CO_2 and stack temperature. If this proves to be impossible, then trouble exists with broken baffles, leaky setting, or dirty heating surface (scale or soot).

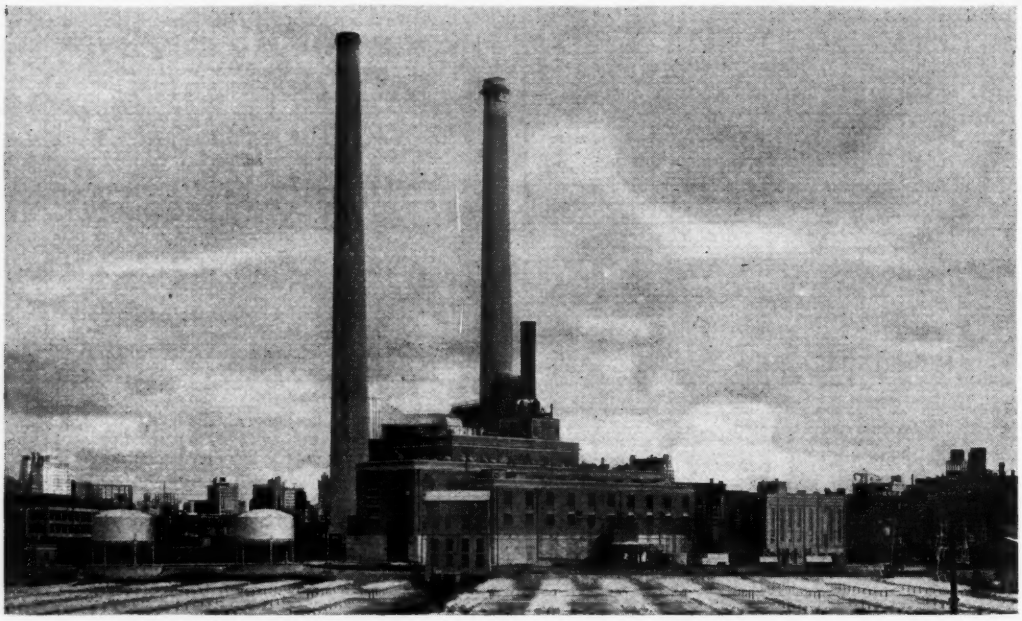


Fig. 1—The Dallas power plant has a generating capacity of 82,500 kw.

HIGH HEAT LIBERATION WITH GAS

IN DALLAS BOILERS

By J. B. NEALEY

THE main generating station of the Dallas Power & Light Company supplies electricity to the city and neighboring territory, its capacity being 82,500 kw., divided between five turbo-generators, two of 25,000 kw. each, a third of 20,000 kw., and two units of 7,500 and 5,000 kw., respectively. The larger turbines operate on 350 lb. pressure and the smaller on 200 lb.; the latter, however, are maintained as standby units only.

Containing twelve boilers in all, the plant is divided into two sections, high- and low-pressure, respectively, six boilers to a section. On the high-pressure side the boilers are of the cross-drum type and are arranged in two rows with the firing aisle between. Seven gas burners are used to fire each of four of these boilers, which have 17,000 sq.ft of heating surface each; thirteen gas burners are used on each of the other two 14,200-sq.ft. boilers. Refractory water walls and regenerative air preheaters with both induced- and forced-draft fans form part of the last two boiler units. Walls of the other four furnaces are air-cooled inside metal casings and this hot air is drawn out through ducts and then forced by fan draft to the burners, where it is utilized for combustion. The temperature of the preheated air ranges from 450 to 540 deg. F. on the two boilers served by preheaters.

The low-pressure boilers, of the longitudinal-drum type, are each equipped with four natural-draft gas burners. These burners are identical with the high-pressure burners with the exception that the latter are completely closed, while openings are left in the others to allow air for combustion to be drawn in by furnace draft from the boiler room. The air in either case is primary; no secondary combustion air is used. In other words, all air necessary for complete combustion is mixed with the gas at the burner entrance.

Pressure in the gas main ranges from 80 to 100 lb. per sq.in. and is carried through to the boiler gas throttle valves, no pressure regulators being employed. Gas at pressures of from 2.5 to 15 lb. is supplied to the burners by throttling; the gas and air velocity is so great that the gas and air are mixed quickly and thoroughly. This in turn promotes combustion and provides a flame sharp and entirely incandescent. Furnace maintenance is reduced to a minimum.

Use of 5 per cent excess air provides economical operation, the carbon-dioxide content of the flue gas being in the neighborhood of 11 per cent. The burners employed are combination gas and oil, the latter fuel being used as standby only. Inasmuch as the station load fluctuates sharply, the gas and oil pressures have been worked out to correspond with the changing steam pressure and steam flow. These are charted for each boiler and the charts placed at the boilers convenient to the operator. Following is a typical chart for the high-pressure boilers:

No. 5 Boiler

Gas Pressure lb. per sq.in.	Oil Pressure lb. per sq.in.	Steam Pressure lb. per sq.in.	Steam Flow lb. per hr.
2.5	30	112	90,000
4.5	35	115	120,000
7	40	117	150,000
9	45	120	180,000
12	50	122	210,000
15	55	125	240,000

Air volume supplied to the burners of the high-pressure boilers is maintained with the aid of Bailey boiler meters equipped with air-flow and steam-flow pens at a predetermined gas-air ratio. The two boilers with the air preheaters are used for base loading. Automatic pressure controllers connected to the uptake dampers are employed to maintain continuously a draft of 0.10 in. water within the furnaces of these two boilers. A lever which makes or breaks an electric current is attached to a bell floating in oil, and the furnace pressure is communicated to the under side of this bell. When the pressure rises above the point set on the controller, the lever makes the circuit that operates a motor to open the uptake damper, and conversely. An hydraulic operated damper in the forced-draft fan discharge duct is employed to regulate the volume of air supplied to the four 17,000-sq.ft. boilers.

The low-pressure boilers presented a slightly different problem. This was solved by equipping them with steam-flow meters, flue-gas temperature recorders and pointer gages to show the difference in draft between the furnace and uptake. Just as for the high-pressure side, tests were made on the low-pressure boilers, at different ratings, to ascertain the amount of increased draft required for each pound increase in the gas pressure at the burner. These were charted and placed on the boiler gage board. A typical example is:

Gas Pressure (lb. per sq.in.)	Difference in Draft (in water)	Steam Flow (lb. per hr.)
5	—0.19	39,600
4	—0.12	35,400
3	—0.065	30,800
2	—0.03	25,800
1	—0.015	18,200

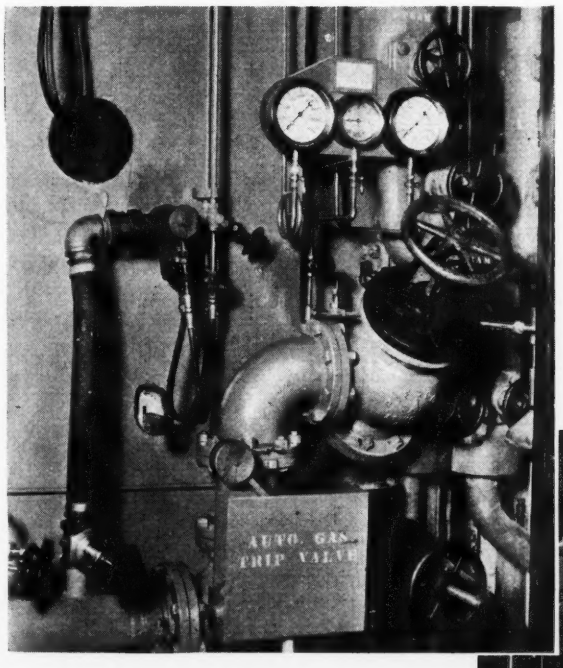


Fig. 2—The large valve controls flow of gas to the burners; the two smaller valves above it control flow of fuel oil and atomizing steam

Although high efficiency is maintained on the newer boilers, use of the older units, fluctuations in load, losses due to bringing idle units up to full pressure in readiness for peaks and other factors bring the average boiler efficiency down to 79.8 per cent, which is very high for a station of this type. The load fluctuates from 10,000 to 50,000 kw., and from one to five boilers are in service at different times during the day. These operating characteristics also mean lower thermal economy for the plant, but in spite of this the average heat consumption for the past year has been only 16,400 B.t.u. per kw.-hr. net output.

Change from Gas to Oil Firing

If, for any reason, it becomes necessary to change from gas to oil firing, this change can be made in ten seconds without any drop in station load and without any burner adjustment. The operator simply opens the atomizing steam throttle valve just enough to provide the required pressure and slowly opens the oil throttle valve until the oil is ignited. Oil pressure is gradually increased and the gas pressure reduced by manipulating the corresponding valves, until the oil burners alone are firing.

Fig. 2 shows the throttle valve set-up for the gas, oil and atomizing steam headers. The gas throttle valve is the large one (6 in.) in the center, while above it are the oil throttling valve and the atomizing steam valve, respectively. Pressure gages shown are (left to right) for atomizing steam, gas and oil, respectively. Above these can be seen a table showing the gas, oil and steam atomizing steam pressures corresponding to any desired boiler output. The automatic gas trip valve is a safety device, solenoid operated, and is part of the equipment of the boilers having air preheaters. It is cut into the gas burner header just after the throttle valve and automatically shuts off the gas flow to the burners in the event the power supply to the draft fans should fail. This prevents the furnaces from filling with gas should the air supply be cut off.

While plant efficiencies here are well in line with those of similar stations, maintenance costs, directly chargeable to gas as fuel, are exceptionally low. Excellent operation, with boiler room labor cost at a minimum, is obtained, and both large and small load fluctuations are handled with ease.

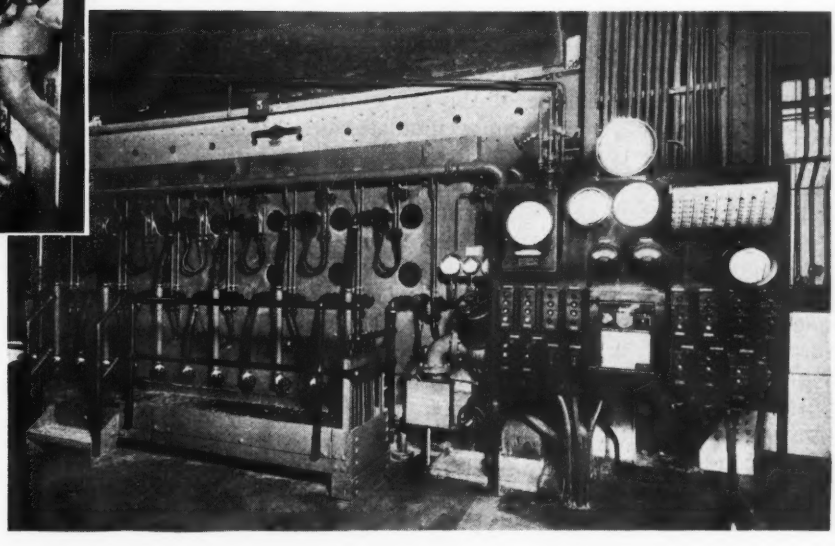


Fig. 3 — With gas firing, the operaitng range is from 100,000 to 240,000 lb. of steam per hr.

A COMPARISON OF THE

Carbonic and Ammonia Refrigeration Cycles

By H. J. McINTIRE
University of Illinois

Refrigeration performance and compressor work are here compared when carbon dioxide and ammonia are used as refrigerants in two-stage compressors and in a dual system using both refrigerants

IT HAS been considered until late years that carbon dioxide was the only desirable refrigerant for installations in which the public were directly exposed as in theatres, hotel and office buildings. This, because carbon dioxide is non-inflammable and is non-irritant and, except in large quantities, not dangerous to human life.

There are, however, certain inherent objections to the use of carbon dioxide as a refrigerant. The pressures are excessive, being usually 900 lb. and over. The critical temperature is 87.8 deg. F., corresponding to a pressure of 1,065 lb. per sq.in., which means that unless the condensing water is 75 deg. F., or less, or unless considerable water is used, the temperature of the carbon dioxide leaving the condenser will be above 87.8 deg. In such a case the condenser cannot possibly liquefy the carbon dioxide, but a dense gas cooled to some temperature approximately that of the exit cooling water will pass to the expansion valve. Also, as will be noted in Fig. 1, the heat of the liquid, given by points on the liquid line corresponding to the temperature at the expansion valve, is a large proportion of the total heat of the dry saturated vapor, which is given by points on the saturated line. That the refrigerant is not condensed and reaches the expansion valve in a gaseous condition does not mean that refrigeration is impossible or inappreciable, as will be seen also from Fig. 1, where the process *AB* represents the action of the expansion valve for one cycle and *EG* for another.

In the development of the carbon-dioxide system, a number of schemes have been attempted in order to improve these inherent faults of the refrigerant, such as, (a) stage compression with an accumulator between the stages, (b) dual compression, using the liquid at the upper evaporation pressure to cool partly the liquid passing to the expansion valve of the low-pressure evaporating coils, (c) the dual-refrigerant cycle and finally (d) the Plank duplex cycle.

The Plank duplex cycle, Fig. 1, consists of a second cooling after compression. In the usual cycle, at pressures above 1,065 lb. per sq.i.n, *EG* would represent the action of the expansion valve, *GC* that of the evaporator during the the refrigerating process, *CD* the usual compression and *DE* the cooling process in the condenser. The second compression is along the line *EF* and the second cooling process is along *FA*, where the points *E* and *A* are identical temperatures, being on the same isothermal line, and are 90 deg. F. in the case shown in Fig. 1. The advantage of the Plank duplex over the ordinary single-compression cycle can be shown by a comparison of the coefficient of performance, *R*, which is defined as the ratio of useful refrigeration to work of compression.

In the cycle *EGCDE*, the coefficient of performance is

$$R_1 = \frac{H_C - H_E}{H_D - H_C} = \frac{137 - 110}{177 - 137} = 0.675$$

In the duplex cycle *ABCDEFA*, the coefficient of performance is

$$R_2 = \frac{H_C - H_A}{(H_D - H_C) + (H_F - H_E)} = \frac{137 - 73}{(177 - 137) + (114 - 110)} = \frac{64}{44} = 1.455$$

As a third comparison, the coefficient of performance could be calculated for a single compression to the pressure at *F* or *A*, which is 1,500 lb. per sq.in., and the cycle becomes *ABCHA*. The coefficient of performance in this case is

$$R_3 = \frac{H_C - H_A}{H_H - H_C} = \frac{137 - 73}{185 - 137} = \frac{64}{48} = 1.33$$

It is evident, on comparison of these results, that for conditions near the critical temperature some special method of operation should be used. Marine engineers have used the last cycle *ABCHA* for years when in tropical waters by the expedient of charging an additional amount of carbon dioxide into the system until the desired pressure was reached. Whether the Plank cycle, involving more apparatus, and showing an additional efficiency of

$$\frac{1.455 - 1.333}{1.333} = \frac{0.122}{1.333} = 9.15 \text{ per cent,}$$

is justified is an open question.

As already mentioned, one of the inherent disadvantages in the use of carbon dioxide lies in the large value of the heat of the liquid, as compared with the latent heat of vaporization. As much as 40 or even 50 per cent of the liquid from the condenser is vaporized at the expansion valve, in cooling the remainder of the liquid from the temperature at which it reaches the expansion valve to that corresponding to the temperature of evaporation in the refrigerating coils. This amount of the liquid is therefore lost for purposes of useful refrigeration.

There would be no advantage in refrigerating effect in cooling the liquid by means of coils using the same temperature and pressure as those in which the useful refrigeration is being carried out. There would be an

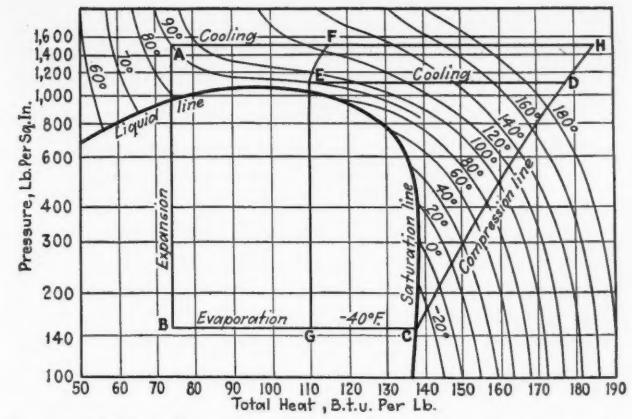


Fig. 1—Mollier diagram showing CO_2 refrigeration cycle when cooling water is above the critical temperature

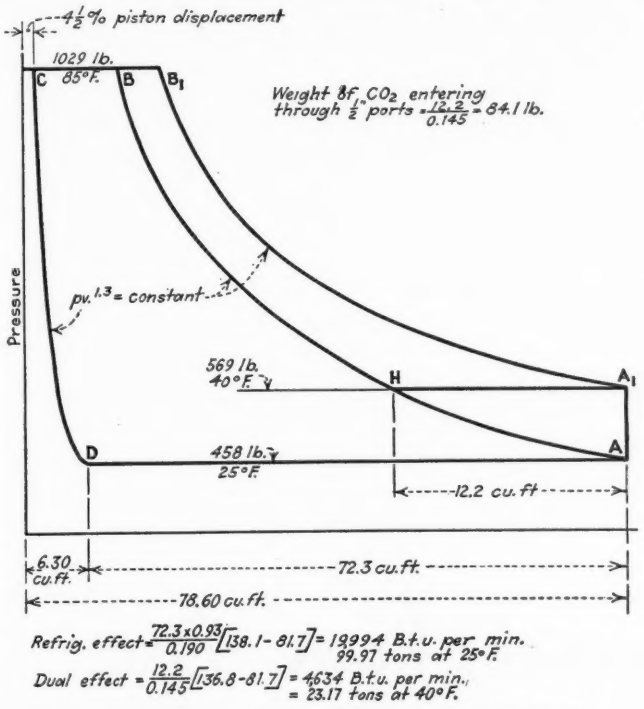

4½% piston displacement
1029 lb.
85°F.
Weight of CO2 entering through ½" ports = 12.2 / 0.145 = 84.1 lb.
Pressure
pv^1.3 = constant
569 lb.
40°F.
458 lb.
25°F.
12.2 cu. ft
6.30 cu. ft.
72.3 cu. ft.
78.60 cu. ft.
Refrig. effect = 72.3 x 0.93 / 0.190 [138.1 - 81.7] = 13994 B.t.u. per min.
99.97 tons at 25°F.
Dual effect = 12.2 / 0.145 [136.8 - 81.7] = 4634 B.t.u. per min.
= 23.17 tons at 40°F.

Fig. 2—Dual-Compression—CO_2 compressor 5¾x18 in. diam., 1¾-in. rod, 150 r.p.m., 93 per cent real volumetric efficiency

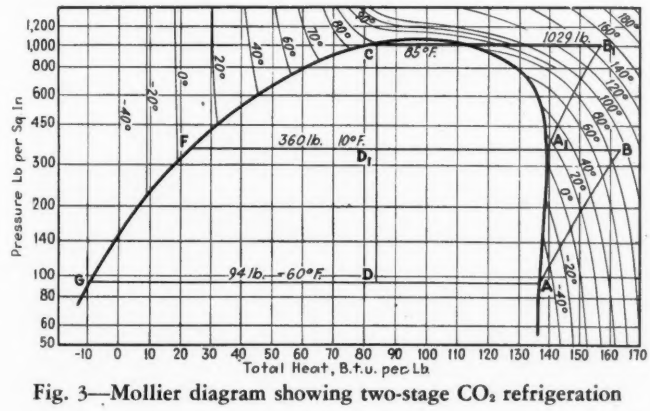


Fig. 3—Mollier diagram showing two-stage CO_2 refrigeration

advantage if liquid was boiled at a *higher temperature* and pressure, because the work of compression decreases as the evaporating pressure rises. Ordinarily, however, this would require a separate compressor to do the cooling. However, in the *dual-compression* system, gas at a higher pressure is admitted through ports in the cylinder uncovered by the piston at the end of the suction stroke, and the pressure rises from the amount shown at A, Fig. 2, to A_1. During the compression stroke the entire weight of carbon dioxide at A_1 is compressed to the condenser pressure at B_1. If the gas entering through the cylinder ports has been evaporated in a pipe coil that cools the liquid passing from the condenser to the evaporating coils, then, according to Fig. 2, there will be an addition of about 23 per cent in the possible refrigeration.

Fig. 2 shows an indicator diagram for a 5¾x18-in. carbonic compressor having a 1¾-in. diameter rod and operating at 150 r.p.m. The clearance is taken as 4½ per cent of the piston displacement, and the high-pressure gas enters through ½-in. ports in the cylinder barrel. When the piston uncovers ports at A, gas at a pressure A_1 enters and, to all intents and purposes, compresses the low pressure gas along the adiabatic line AH, thereby making it possible for a volume of the gas at the upper pressure to enter the cylinder equal in amount to the difference in volumes at H and A_1.

Taking the conditions of operation given in Fig. 2, the weight of carbon dioxide drawn into the cylinder per minute during the suction stroke DA, assuming a real volumetric efficiency of 0.93, is

$$\frac{72.3 \times 0.93}{0.190} = 354.5 \text{ lb.},$$

whereas the weight entering through the cylinder ports, per minute is

$$\frac{78.6 - 66.4}{0.145} = 84.1 \text{ lb.},$$

which is capable of absorbing

$$84.1\,(136.8 - 81.7) = 4{,}634 \text{ B.t.u.}$$

As this 4,634 B.t.u. per min. is used for the purpose of cooling the liquid, the actual temperature at the expansion valve can be calculated according to the following equation:

$$354.5\,(h_{85°} - h_x) = 4634 \text{ B.t.u.}$$
$$354.5\,(81.7 - h_x) = 4634$$

Therefore, $h_x = 68.8$ B.t.u., and this corresponds to a temperature of the liquid of nearly 74 deg. F. The reduction of the temperature has not been great, only about 11 deg., and the 23 per cent increase in refrigeration has not been all profit. This can be seen by the difference in the areas $ABCDA$ and AA_1B_1CDA. However, there is enough practical advantage to make it worth while, and dual compression is widely used.

In stage compression, Fig. 3, there is little opportunity in the case of carbon dioxide of cooling the discharge gas from the low-pressure cylinder by the use of cooling water. The only advantage, besides improving the real volumetric efficiency, is in the ability to separate the gas evolved during the process CD_1, which is 50.44 per cent in this case, and permitting it to pass to the high-pressure cylinder immediately, where it will be compressed, with the discharge from the low-pressure cylinder and the intercooler, if there is one, to the pressure in the condenser.

Lately there has been considerable interest in a combination of two refrigerants using carbon dioxide for the low- and ammonia for the high-pressure cylinder, the ammonia evaporating coils being utilized to provide liquefaction at or near 0 deg. F. of the carbon dioxide.

The advantages are that the piping is nominal in diameter and that there is no vacuum on any part of the system. The ammonia part of the cycle will operate at its best range, whereas the carbonic machine will not have excessive pressures, since they are limited in this case to from about 100 to 500 lb. per sq.in. Here again the advantages are not all net, for the refrigerating load on the ammonia machine is about 25 per cent greater than the useful refrigeration on the carbonic machine. This is because of the necessity of removing the heat of compression of the carbonic machine and because the evaporating temperature of the ammonia cycle must be sufficiently below liquefaction temperature of the carbon dioxide to permit heat transfer without excessive condenser surface.

To make a theoretical comparison of the possibilities of this combined cycle, several liquefaction temperatures for carbon dioxide have been taken with the constant extreme temperature limits of —60 and +85 deg. F. The object of this is to see whether any optimum condition can be obtained by varying the refrigerating load between the two machines. To obtain a better comparison, the two-stage ammonia and the two-stage carbonic cycle with the same extreme limits have been included, using in every case the coefficient of performance, which is the ratio of the *useful* refrigeration to the work of compression, as the means of comparison.

In making calculations it seemed desirable to calculate the work of compression by using the exponent 1.3 for k during adiabatic compression. In the dual-refrigerant cycle, liquefaction of carbon dioxide is calculated at 5, 15 and 25 deg., while in the two-stage ammonia compressor the temperature in the accumulator is taken as 10 deg. In no case is there any attempt made to allow for the real volumetric efficiency, as such values are not obtainable for carbon dioxide with any accuracy, although accurate test data are available for the real volumetric efficiency of ammonia compressors. For comparison the theoretical values should suffice.

	Temp. Saturation Corresponding to disch. pres. from L.p. cyl. °F.	Work Performed in L.p. cyl. in B.t.u. per ton Refrig.	Work Performed in h.p. cyl. in B.t.u. per ton Refrig.	Total Work of Compression per Ton Refrig. in B.t.u.	Coef. of Performance
Dual-Refrigerant CO_2-NH_3 cycle.....	5	41.2	56.6	97.8	2.05
	15	50.0	48.8	98.8	2.02
	25	59.7	42.3	102.0	1.96
Two-stage CO_2 Compression.	10	45.5	82.9	128.4	1.56
Two-Stage NH_3 Compression.	10	42.3	42.8	85.1	2.35

The table gives the result of the calculations, which are conclusive as far as the power input to the compressor is concerned. It will be seen from this table that the ammonia compressor is more efficient than is the carbonic compressor, and on this basis of comparison there is no advantage in the use of the carbon-dioxide compressor. In the case of the dual-refrigerant cycle, better results are obtained by lowering the temperature of liquefaction of the carbon dioxide for the reasons just stated, for, as the table shows, the coefficient of performance approaches that for two-stage ammonia compression as the temperature approaches —60 deg. F.

Where carbon dioxide is used, other reasons besides the horsepower per ton of refrigeration, or the coefficient of performance, should be the deciding factor. It is hardly to be expected that the absence of pressures below that of the atmosphere are reasons for a choice when good design is considered and when modern purging devices are available. Neither does it seem that the large pipe sizes required for the suction return to the low-pressure cylinder should be a factor of deciding importance.

Blandin Paper Modernizes Power Plant
TO MEET PRICE CUT

By A. J. KULL
Chief Engineer, Blandin Paper Company

Can the power plant aid in meeting reduced prices for products? Blandin Paper Company finds installation of new 450-lb. pulverized-coal-fired boiler to be the best method for further reducing production costs

PAPER prices have declined steadily through the past several years, in many cases forcing paper companies to drastic economies to meet price slashes. Originally, Blandin Paper Company planned a new power plant at its Grand Rapids, Minn., factory, but the uncertainty of the future in the newsprint field led to a more conservative decision. New equipment to meet immediate needs was chosen and arranged so that it would form the basis of a new plant, which would be obtained simply by adding similar units as conditions warranted.

The old boiler room was occupied by two large boilers and two 3,000-sq.ft. Geary boilers, all operating at 200 lb. pressure. One of the smaller boilers was equipped with an obsolete stoker, and the setting was in very poor condition, so it was decided to remove this unit. By raising the roof 22 ft. 2 in. sufficient head room was made available for a new boiler. Costs were kept at a minimum by raising only that portion of the roof directly over the new boiler. Conveyor and bunker were left in their present position.

The boiler unit selected was designed to deliver

90,000 lb. of steam an hour at 450 lb. pressure and 670 deg. temperature. It is a Foster Wheeler, four-drum, bent-tube type boiler with 6,680 sq.ft. of radiation. The pulverized-coal furnace is built with three water-cooled walls and refractory front wall. It has a total volume of 6,000 cu.ft., and is designed for efficient combustion of coal at rates up to 14,000 lb. per hr.

The two side walls consist of bare water tubes placed in front of solid refractory walls. The water-cooled rear wall has two portions, an upper vertical wall consisting of bare tubes in front of solid refractory, and a lower inclined portion made of armored water-wall elements backed by insulation. The inclined water tubes are protected by cast-iron blocks which make tight contact with the tubes due to pressure exerted by a toggle construction. A smooth surface, to which the powdered coal slag does not adhere, is formed on the fire side of the inclined wall.

Air for combustion is supplied through a tubular-type air preheater of 9,580 sq.ft. Flue gas leaves the air preheater at a temperature of 330 deg., and the air is heated to 375 deg. An extended heating surface-type economizer of 1,404 sq.ft. is also provided to heat the feed water from 210 to 270 deg.

Draft is provided by induced- and forced-draft fans driven by 50- and 7½-hp. motors, respectively.

Feed water is delivered through the economizer at a temperature of 210 dg. by either a motor-driven or a turbine-driven feed pump which receives the water from an Elliott deaerating heater.

In 1931, a new high-speed paper machine was installed, and at that time a 5,000-kw. turbine was purchased. This unit was designed to operate with steam at 185 lb. pressure and was so arranged that at a later date it could be changed for operation at 450 lb. This change has been made, and the present new boiler is used only to furnish steam for the 5,000-kw. turbine, the two units operating as one.

If at any time it becomes necessary to shut the boiler down, the piping is arranged so that the old boilers can furnish steam at 185 lb. pressure to the high-pressure turbine, which can generate approximately 4,000 kw. at the lower pressure.

All of the pure condensate is returned to the new deaerating heater. This condensate is more than is at any time required by the new boiler, so the overflow from this heater runs to the old open heater located at a lower level. The old heater serves the old low-pressure boilers.

To avoid contaminating the feed water for the new boiler during a possible shortage of pure condensate, an old tank holding about 1,000 gal. was placed directly below the new feed-water heater to provide additional storage capacity. As an additional precaution, a make-up water line was installed between the old 200-lb. pressure feed-water pump and the new heater so that water from the old heater can be used instead of raw water from the river as make-up. Water from the old heater is 90 per cent condensate and 10 per cent river water. In the new boilers, the water has a hardness of 0.9, and a sulphate carbonate ratio of 4 to 1 is maintained by adding glaubers salt to the water.

When conditions warrant the expenditure, two additional high-pressure boilers can be installed. At that time the remainder of the roof will be raised and the coal bunker also raised sufficiently to give the boiler room considerably more space at the operating floor level.

The engineering work was done by R. E. Lutz, of Minneapolis, and the author.

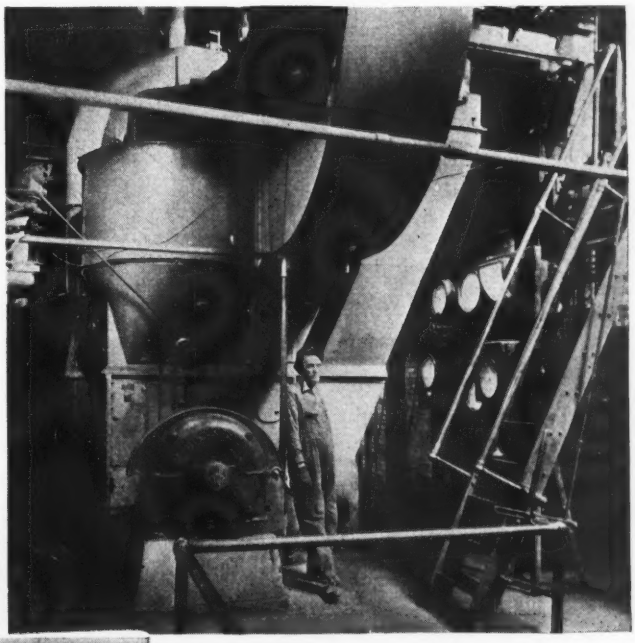


Fig. 1 (Above)—Coal is pulverized in a 7-ton unit mill

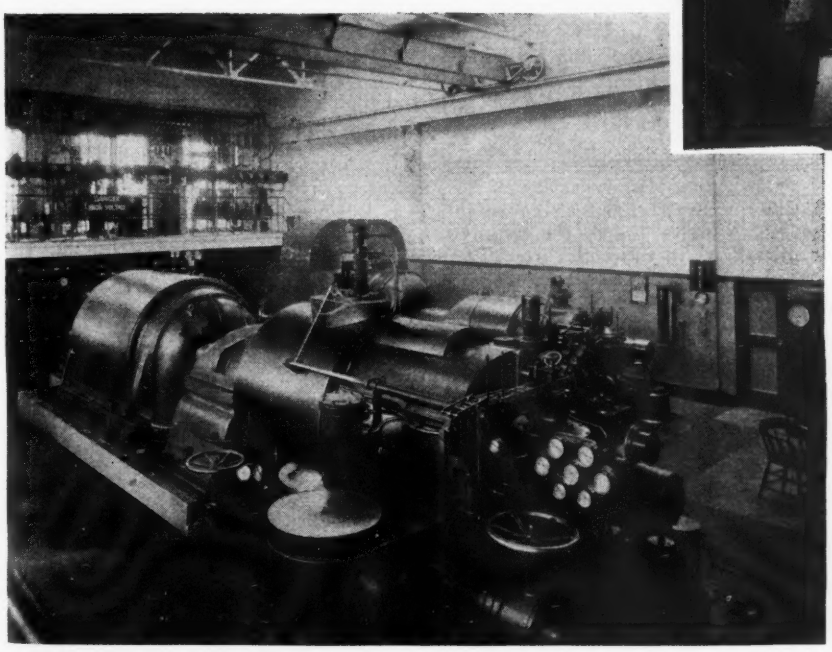


Fig. 2 (Left)—This 5,000-kw. unit, originally designed for 185-lb. pressure, has been reconditioned for operation with 450-lb. steam

PLAIN TALK on N. I. R. A.

1. What is NIRA?
The National Industrial Recovery Act passed by Congress June 13, 1933.

2. Who administers it?
NRA, the National Recovery Administration, headed by two-fisted Gen. Hugh Johnson.

3. Who has the final say?
President Roosevelt.

4. What does NIRA do?
It permits the President, through General Johnson, to decide, after a hearing, how any industry is to be run — its wages, hours, trade practices or anything else.

5. Do the President and General Johnson plan to exercise this dictatorship?
According to their own statements, only when necessary. They much prefer to let industries run their own affairs, provided only that they improve employment conditions and smother chiseling. Industries are invited to submit their own codes for approval.

6. What will induce industries to submit codes?
The knowledge that they can gain certain advantages by doing so and also the knowledge that the President, according to the law, has the right to impose a code of his own choosing.

7. Does the President have to accept a code agreed upon by the industry?
No.

8. Does NIRA tell how to write a code?
No.

9. Will General Johnson tell how to write a code?
No.

10. Are there any definite rules about codes?
Yes; NIRA specifies that every code must: (a) Improve employment conditions; (b) specify minimum wages; (c) specify maximum hours; (d) eliminate or limit unfair competition.

11. Where can I get the details?
Read the law.

12. What else may be in a code?
Read the law and you will see that almost anything under heaven may be in a code as long as the code suits the industry and does not hinder national recovery. If the industry wants to agree to wear pink shirts, it will be O.K. as far as the law is concerned. But remember that the President, through General Johnson, has always the right to pass upon the final code, accept it, turn it down, or change it.

13. Who is the final judge?
First, General Johnson, and then the President, with the final power entirely in the hands of the President as far as he cares to exercise it. Read the law.

14. Is this not then self-government of industry rather than a dictatorship?
Yes. So far as, and as long as, the President is satisfied with the code, each industry sets up for its self government.

• POWER MEN, along with all other industrial executives, now stand face to face with the National Industrial Recovery Act. They will be expected to help industry make its own decisions —right. This Act, and the acts of industrial men under it, will directly affect every man, woman and child in the United States. For the time being, business levels have been abolished. We start at once to move up or to slide down. Action is certain. The hope is that this action will be based on knowledge of facts. On this page are the high spots of NIRA, boiled down to questions and answers for busy men. For more information, get the law and read it; it's short. The answers are based upon a careful reading of the law and other official documents. They are also based upon direct contact in Washington with high officials administering this law.

15. Can prices be fixed to cover increased labor costs due to the required labor provisions in the code?
Not by direct price fixing or monopoly, but industries are encouraged to forbid selling below cost and otherwise to eliminate unfair competition, chiseling.

16. Will the consumer be entirely satisfied with the Act?
No; he will kick when the price of shoes and bread goes up, particularly if the rise precedes his rise in wages.

17. Will the business man be satisfied?
No; he will kick because the law or his industry code gives some competitor a real or imagined advantage.

18. Will the worker be satisfied?
No; he will kick because anti-trust laws have been sidetracked to give business a chance to make a profit once more.

19. What will this kicking mean?
Primarily that the NIRA is not written to benefit any particular class, but rather the whole U. S. It offers jobs and pay to workers, potential profits to business men, and it places on each group certain restrictions to make these benefits economically and politically possible.

20. Will this ambitious plan work?
It is already working. Watch prices, wages, employment. In the long run it is an experiment, as Washington is the first to admit. But it is an intelligent experiment administered by practical men with brains and courage. Looks like better than a 50-50 shot for ultimate success.

21. What about the stock market?
Wall Street is a side show where people gamble on the performances in the main tent. Stock gyrations will neither make nor unmake business recovery unless people confuse the side show with the circus.

22. What will I have to read to get a clear understanding of NIRA in detail?
Just four documents: National Industrial Recovery Act of June 13, 1933; NRA Bulletin No. 1 (the President's statement); NRA Bulletin No. 2 (General Johnson's statement). NRA Bulletin No. 3 "The President's Re-employment Program". Tells about the "blanket code." These four documents may be obtained free by writing to the U. S. Government Printing Office, Washington, D. C.

23. Any other reading matter?
Yes. Tons of codes, near-codes, newspaper releases, interviews, facts and guesses. But first read and re-read the documents listed above. After that you may get helpful hints by studying some of the basic codes that have already gotten by. Examples: Cotton Textiles, Electrical Manufacturing.

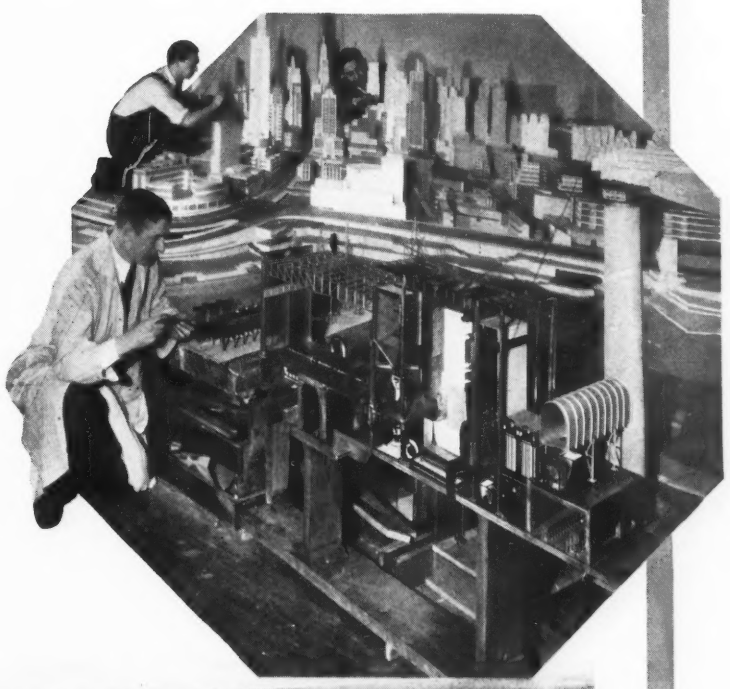
24. What code will power engineers and their staffs come under?
No single code, but the code of the particular industry in which each is employed. Watch that for rules on hours, wages and so forth.

25. Does the law forbid or discourage the modernization of plant equipment?
No.

26. What about the new "Blanket Code" for all U .S. industries?
This is really not a code (see NRA Bulletin No. 3), but a voluntary agreement which each group or individual makes with the President. It will not apply to industries whose codes are accepted. It therefore serves two essential ends: stimulates the making of industry codes and tides over the gap until they are approved. This latest movement is absolutely necessary to prevent the nation's buying power from lagging too far behind prices and production. Hearty cooperation is urged as a matter of good business as well as sound public policy.

POWER IN MINIATURE

Some models aid engineers and executives (see page 405); these instead provide John Public with graphic information on three types of electrical generating plants, low-head hydro (below), high-head hydro, and steam (right). Part of the 90-ft. diorama of the Electrical Central Station Industry exhibit at the Century of Progress Exposition, these working models are centers of interest for public and engineers as well



Apex photos

STOKER LU

● Today there are three types of mechanical stokers in common use.

1. The chain or traveling grate
2. The underfeed
3. The overfeed.

The lubrication of the various types of stokers can be divided into four general subjects:

1. Bearings
2. Reduction gears
3. Power units
4. Steam or Hydraulic Rams.

Bearings usually used on stokers are of the plain type equipped for grease lubrication by compression cups or pressure gun fittings. Frequent greasing is desirable because the excess acts as a seal preventing dust and dirt from getting into the bearing. A good grade of cup grease of No. 3 or No. 4 consistency is a satisfactory product for this service. In some cases bearings have oil holes for hand oiling. They should have a suitable oiling device or plug to prevent coal dust and dirt from getting into the bearing or clogging the oil hole. Because of the very slow motion and high pressure encountered, an oil of heavy body should be used.

The reduction gears used for stoker drives can be divided into two classes:

1. Worm gears
2. Planetary or Spur gears.

Worm and double worm reduction gears are frequently used, because stokers normally operate at slow speeds and this requires large reductions in the speed of the power unit, particularly when turbines or electric motors are the source of power. Units of the worm gear type are usually enclosed in oil tight cases. If the drive is by belt from a line shaft and the speeds slow, the gears may be exposed or equipped with only a safety guard.

The selection of a lubricant for a worm gear depends largely on the speed, type of case, kind of metals used, location and type of bearings, method used for their lubrication and the location of the worm with respect to the gear. In general, a comparatively heavy and adhesive lubricant is required, which will not wipe off when subjected to the pressure and sliding action of the gear teeth at the operating temperature. If the bearings must be lubricated by splash or throw-off from the gears it is necessary to compromise and use a lower viscosity product.

A good grade of steam cylinder oil ordinarily is used for worm gears which have oil tight cases. If the gears have only a guard it is necessary to use a heavy adhesive gear compound and apply it frequently by hand. Normally a combination of bronze on steel is used in worm gear construction. In some instances, the combination is steel on steel, and with this combination E. P. (extreme pressure) lubricants should be used.

Planetary or spur gear reduction units have essentially a rolling action between the gear teeth and operate at higher speeds. This requires the use of lower viscosity oils. The lubrication of gear units of this type is covered in more detail in Monograph No. 6.

The power units for operating stokers are electric motors, steam turbines and steam engines. Electric motor and steam turbine lubrication has been covered in previous monographs. Steam engines most commonly used are of the vertical single acting type and deserve brief mention.

The cylinders are lubricated in the customary manner by hydrostatic or mechanical force feed lubricators. To prevent excess oil from getting into the crankcase, the feed should be kept as low as possible. The bottom portion of the piston and cylinder as well as the bearings are lubricated by splash from the crankcase. Some of the older engines of this type were equipped with oil cups for the lubrication of the main bearings. Crankcase temperatures are usually high, necessitating the use of a heavy oil which in most cases is floated on water. A mineral oil of the very highest quality is required to prevent the water from becoming mixed with the oil in the form of a permanent emulsion. If excessive condensate containing considerable cylinder oil finds its way to the crankcase, emulsions may result even though the oil is of the very best quality. This is because of the compounding present in the cylinder oil.

The steam ram because of its slow and intermittent operation presents an important lubricating problem, particularly if superheated steam is used. The high temperatures and slow movement which expose the lubricant to these temperatures for a considerable time tend to cause carbonization and gumming to take place. In many cases arrangements are made so that saturated steam can be obtained when units of this type are used with boilers generating steam with high superheat.

The steam velocity to the ram is very low which makes it difficult to obtain satisfactory atomization of the cylinder oil, thus resulting in poor distribution of the oil over the rubbing surfaces. It is preferable to pipe the steam to the ram in such a way that the travel is downward from the point at which the cylinder oil is introduced. If the steam has to flow upward, the velocity is usually insufficient to overcome the force of gravity which tends to cause the oil to drop away from the cylinder. A cylinder oil of the very highest quality should be used on steam rams—an oil that will adhere to the rubbing surfaces the maximum length of time without gumming or carbonizing and that will atomize very readily.

Hydraulic rams are self-lubricating because the hydraulic fluid itself is an oil. The body or viscosity of the fluid is governed by the type or kind of hydraulic power transmission system used by the manufacturer.

Efficient and thorough lubrication of mechanical stokers is an important part of steam power plant operation. It is necessary to prevent undue wear and to keep the power consumed by these units to a minimum. Upon the successful operation of this important part of a power plant will depend the smooth, accurate control and high efficiency that is the aim of every engineer today.

STANDARD OIL COMPANY
(Indiana)
910 S. Michigan Ave. Chicago, Illinois
1820

UBRICATION

FIRST BE CERTAIN THAT YOU USE THE CORRECT LUBRICANTS

The same reason — savings — that prompts the use of mechanical stokers dictates the most careful selection of lubricants for them.

No one type of lubricant can lubricate effectively all types of mechanical stokers under all operating conditions. At the Standard Oil Company (Indiana) laboratories the lubrication requirements for all makes of mechanical stokers have been studied and lubricants developed to exactly meet each need. These lubricants have been tested in the power plants at our various refineries and in the field. Their effectiveness has been proved.

It costs you nothing to be sure that your mechanical stokers are properly lubricated. Any Standard Oil Lubrication Engineer will check your stoker lubrication, make a complete report and, if necessary, recommendations. This service is offered without cost and it pays. It prevents possibility of trouble from faulty lubrication. It assures you of those savings in fuel costs that correctly lubricated mechanical stokers make possible.

Place all of your lubrication problems in the hands of Standard Oil Lubrication Engineers. Profit by their wide experience and the great facilities of the Standard Oil Company (Indiana).

STANDARD OIL COMPANY (INDIANA) SERVICE

PIPE DATA

Nominal Pipe Size	Diameter Inches: External	Diameter Inches: Internal	Diameter Inches: Thickness	Threads: Per Inch	Threads: Length of Perfect	Threads: Number of Perfect	Circumference Inches: Outside	Circumference Inches: Inside	Transverse Area Square Inches: External	Transverse Area Square Inches: Internal	Transverse Area Square Inches: Metal	Length in Ft. Per Sq. Ft.: External Surface	Length in Ft. Per Sq. Ft.: Internal Surface	Length of Pipe Containing One Cu. Ft.	Contents in Gal. Per Lineal Foot	Weight Per Lin. Foot Plain Ends Lb.	Weight of Water Per Lin. Foot Lb.	Sq. Ft. of Heating Surface Per Lin. Foot	Moment of Inertia	Section Modulus	Radius of Gyration	Radius of Gyration Squared	List Price Per Lin. Foot	Nominal Pipe Size
STANDARD WEIGHT PIPE																								
⅛	0.405	0.269	0.068	27	0.264	5.12	1.272	0.845	0.129	0.057	0.072	9.431	14.199	2533.775	0.00296	0.24	0.0247	0.106	0.001064	0.005252	0.1215	0.01477	$0.05½	⅛
¼	0.540	0.364	0.088	18	0.402	5.23	1.696	1.144	0.229	0.104	0.125	7.073	10.493	1383.789	0.00540	0.42	0.0450	0.141	0.003312	0.01227	0.1628	0.02651	0.06	¼
⅜	0.675	0.493	0.091	18	0.408	5.34	2.121	1.549	0.358	0.191	0.167	5.658	7.748	754.360	0.00992	0.57	0.0826	0.177	0.007291	0.02160	0.2090	0.04367	0.06	⅜
½	0.840	0.622	0.109	14	0.534	5.47	2.639	1.954	0.554	0.304	0.250	4.547	6.141	473.906	0.0158	0.85	0.132	0.220	0.01709	0.04069	0.2613	0.06828	0.08½	½
¾	1.050	0.824	0.113	14	0.546	5.64	3.299	2.589	0.866	0.533	0.333	3.637	4.635	270.034	0.0276	1.13	0.230	0.275	0.03704	0.07055	0.3337	0.1113	0.11½	¾
1	1.315	1.049	0.133	11½	0.683	5.85	4.131	3.296	1.358	0.864	0.494	2.904	3.641	166.618	0.0449	1.68	0.374	0.344	0.08734	0.1328	0.4205	0.1769	0.17	1
1¼	1.660	1.380	0.140	11½	0.707	6.13	5.215	4.335	2.164	1.495	0.669	2.301	2.768	96.275	0.0774	2.27	0.645	0.435	0.1947	0.2346	0.5397	0.2913	0.23	1¼
1½	1.900	1.610	0.145	11½	0.724	6.32	5.969	5.058	2.835	2.036	0.799	2.010	2.372	70.733	0.106	2.72	0.883	0.497	0.3099	0.3262	0.6226	0.3876	0.27½	1½
2	2.375	2.067	0.154	11½	0.757	6.70	7.461	6.494	4.430	3.355	1.075	1.608	1.847	42.913	0.174	3.65	1.450	0.622	0.6657	0.5606	0.7871	0.6196	0.37	2
2½	2.875	2.469	0.203	8	1.138	7.10	9.032	7.757	6.492	4.788	1.704	1.328	1.547	30.077	0.248	5.79	2.070	0.753	1.530	1.064	0.9474	0.8976	0.58½	2½
3	3.500	3.068	0.216	8	1.200	7.60	10.996	9.638	9.621	7.393	2.228	1.091	1.245	19.479	0.383	7.58	3.190	0.916	3.017	1.724	1.164	1.354	0.76½	3
3½	4.000	3.548	0.226	8	1.250	8.00	12.566	11.146	12.566	9.886	2.680	0.954	1.076	14.565	0.513	9.11	4.280	1.048	4.788	2.394	1.337	1.787	0.92	3½
4	4.500	4.026	0.237	8	1.300	8.40	14.137	12.648	15.904	12.730	3.174	0.848	0.948	11.312	0.660	10.79	5.500	1.179	7.233	3.214	1.510	2.279	1.09	4
*4½	5.000	4.506	0.247	8	1.350	8.80	15.708	14.156	19.635	15.947	3.688	0.763	0.847	9.030	0.826	12.54	6.880	1.310	10.44	4.177	1.683	2.832	1.27	*4½
5	5.563	5.047	0.258	8	1.406	9.25	17.477	15.856	24.306	20.006	4.300	0.686	0.756	7.198	1.04	14.62	8.660	1.458	15.16	5.451	1.878	3.526	1.48	5
6	6.625	6.065	0.280	8	1.513	10.10	20.813	19.054	34.472	28.891	5.581	0.576	0.629	4.984	1.50	18.97	12.500	1.736	28.14	8.496	2.245	5.042	1.92	6
*7	7.625	7.023	0.301	8	1.613	10.90	23.955	22.063	45.664	38.738	6.926	0.500	0.543	3.717	2.01	23.54	16.800	1.990	46.52	12.200	2.592	6.716	2.38	*7
8	8.625	7.981	0.322	8	1.713	11.70	27.096	25.073	58.426	50.027	8.399	0.443	0.478	2.878	2.60	28.55	21.700	2.262	72.49	16.810	2.938	8.630	2.88	8
*9	9.625	8.941	0.342	8	1.813	12.50	30.238	28.089	72.760	62.786	9.974	0.396	0.427	2.294	3.26	33.91	27.200	2.515	107.6	22.350	3.284	10.79	3.45	*9
10	10.750	10.020	0.365	8	1.925	13.40	33.772	31.479	90.763	78.855	11.908	0.355	0.381	1.826	4.10	40.48	34.200	2.817	160.7	29.90	3.674	13.50	4.12	10
*11	11.750	11.000	0.375	8	2.025	14.20	36.914	34.558	108.434	95.033	13.401	0.325	0.347	1.415	4.94	45.56	41.200	3.075	217.0	36.93	4.024	16.19	4.63	*11
12	12.750	12.000	0.375	8	2.125	15.00	40.055	37.699	127.676	113.097	14.579	0.299	0.318	1.273	5.87	49.56	48.900	3.344	279.3	43.82	4.377	19.16	5.07	12
EXTRA STRONG PIPE																								
⅛	0.405	0.215	0.095	27	0.264	5.12	1.272	0.675	0.129	0.036	0.093	9.431	17.766	3966.393	0.00187	0.31	0.01557	0.106	0.001216	0.006004	0.1146	0.01314	$0.12	⅛
¼	0.540	0.302	0.119	18	0.402	5.23	1.696	0.949	0.229	0.072	0.157	7.073	12.648	2010.290	0.00374	0.54	0.0312	0.141	0.003766	0.01395	0.1547	0.02393	0.07½	¼
⅜	0.675	0.423	0.126	18	0.408	5.34	2.121	1.329	0.358	0.141	0.217	5.658	9.030	1024.689	0.00732	0.74	0.0610	0.177	0.008619	0.02554	0.1991	0.03966	0.07½	⅜
½	0.840	0.546	0.147	14	0.534	5.47	2.639	1.715	0.554	0.234	0.320	4.547	6.995	615.017	0.01216	1.09	0.1012	0.220	0.02008	0.04780	0.2505	0.06273	0.11	½
¾	1.050	0.742	0.154	14	0.546	5.64	3.299	2.331	0.866	0.433	0.433	3.637	5.147	333.016	0.0224	1.47	0.1855	0.275	0.04479	0.08531	0.3214	0.1033	0.15	¾
1	1.315	0.957	0.179	11½	0.683	5.85	4.131	3.007	1.358	0.719	0.639	2.904	3.991	200.193	0.0374	2.17	0.312	0.344	0.1056	0.1606	0.4066	0.1653	0.22	1
1¼	1.660	1.278	0.191	11½	0.707	6.13	5.215	4.015	2.164	1.283	0.881	2.301	2.988	112.256	0.0666	3.00	0.555	0.435	0.2418	0.2913	0.5237	0.2743	0.30	1¼
1½	1.900	1.500	0.200	11½	0.724	6.32	5.969	4.712	2.835	1.767	1.068	2.010	2.546	81.487	0.092	3.63	0.766	0.497	0.3912	0.4118	0.6052	0.3663	0.36½	1½
2	2.375	1.939	0.218	11½	0.757	6.70	7.461	6.092	4.430	2.953	1.477	1.608	1.969	48.766	0.1532	5.02	1.277	0.622	0.8679	0.7309	0.7665	0.5875	0.50½	2
2½	2.875	2.323	0.276	8	1.138	7.10	9.032	7.298	6.492	4.238	2.254	1.328	1.644	33.976	0.2195	7.66	1.83	0.753	1.924	1.339	0.9241	0.8539	0.77	2½
3	3.500	2.900	0.300	8	1.200	7.60	10.996	9.111	9.621	6.605	3.016	1.091	1.317	21.801	0.342	10.25	2.85	0.916	3.894	2.225	1.136	1.291	1.03	3
3½	4.000	3.364	0.318	8	1.250	8.00	12.566	10.568	12.566	8.888	3.678	0.954	1.135	16.202	0.462	12.51	3.85	1.048	6.280	3.140	1.307	1.707	1.25	3½
4	4.500	3.826	0.337	8	1.300	8.40	14.137	12.020	15.904	11.497	4.407	0.848	0.998	12.525	0.596	14.98	4.97	1.179	9.610	4.271	1.477	2.181	1.50	4
*4½	5.000	4.290	0.355	8	1.350	8.80	15.708	13.477	19.635	14.455	5.180	0.763	0.890	9.962	0.750	17.61	6.25	1.310	14.05	5.621	1.647	2.712	1.80	*4½
5	5.563	4.813	0.375	8	1.406	9.25	17.477	15.120	24.306	18.194	6.112	0.686	0.793	7.915	0.947	20.78	7.90	1.458	20.67	7.431	1.839	3.382	2.08	5
6	6.625	5.761	0.432	8	1.513	10.10	20.813	18.099	34.472	26.067	8.405	0.576	0.663	5.524	1.352	28.57	11.28	1.736	40.49	12.22	2.195	4.817	2.86	6
*7	7.625	6.625	0.500	8	1.613	10.90	23.955	20.813	45.664	34.472	11.192	0.500	0.576	4.177	1.790	38.05	14.91	1.990	71.37	18.72	2.525	6.377	3.81	*7
8	8.625	7.625	0.500	8	1.713	11.70	27.096	23.955	58.426	45.663	12.763	0.443	0.500	3.154	2.37	43.39	19.75	2.262	105.7	24.51	2.878	8.283	4.34	8
*9	9.625	8.625	0.500	8	1.813	12.50	30.238	27.096	72.760	58.426	14.334	0.396	0.442	2.465	3.04	48.73	25.35	2.515	149.6	31.09	3.231	10.44	4.90	*9
10	10.750	9.750	0.500	8	1.925	13.40	33.772	30.631	90.763	74.662	16.101	0.355	0.391	1.929	3.88	54.74	32.30	2.817	212.0	39.43	3.628	13.16	5.48	10
*11	11.750	10.750	0.500	8	2.025	14.20	36.914	33.772	108.434	90.763	17.671	0.325	0.355	1.587	4.73	60.08	39.40	3.075	280.1	47.68	3.981	15.85	6.10	*11
12	12.750	11.750	0.500	8	2.125	15.00	40.055	36.914	127.676	108.434	19.242	0.299	0.325	1.328	5.64	65.42	47.00	3.344	361.5	56.71	4.335	18.79	6.55	12

*These sizes are listed as standard but are not commonly used.

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DOUBLE-ACTING DOLLARS FOR DIESEL FUEL

This third article of the series describes methods of determining how much waste heat is available for a specific use and how that heat can be used. Summarized from data supplied from over 200 sources, including manufacturers and users

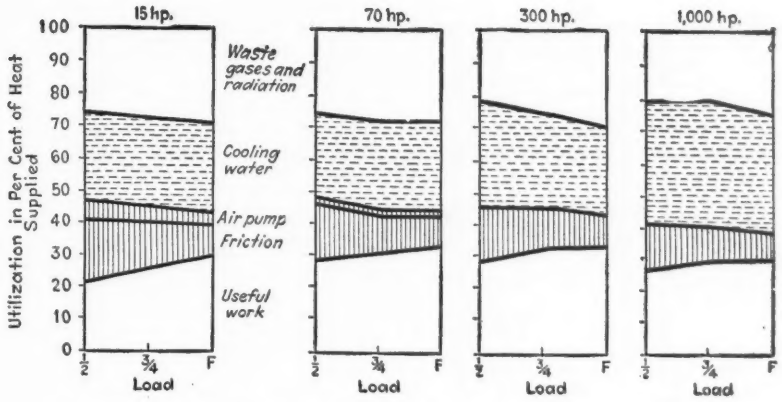


Fig. 1—Heat distribution of diesels of various sizes under various loads

SIMPLICITY is the keynote of the successful installation for recovering diesel waste heat. Installations recovering only a portion of the heat available are usually more simple than those recovering the last available increment, and a careful study of heat balances should be made to determine how much of the waste heat available is economically recoverable in each particular case.

The usual procedure is to determine the amount of steam it is possible to get by utilizing the waste heat, and a credit is given to the power plant of so much per thousand pounds of steam. If this steam supplements the present supply, its value is only the fuel saving, which is generally about 25 cents per 1,000 lb. of steam. However, if it is sufficient to take care of all needs, so that no auxilairy boiler need be operated, the worth of the steam immediately rises to about 60 cents per 1,000 lb. Thus, it can be seen readily that in the case in which almost enough steam could be obtained with cheaper equipment, and enough to avoid a boiler installation by using more expensive equipment, the additional steam might justify the slight additional expense.

If hot water can be used at the cooling water outlet temperature, and if a continuous make-up supply of proper water is available, heated engine jacket water can be used directly. Or, if the engine jackets are connected into a closed hot-water radiator heating system, the water returning from the heating system can be run through the engine jackets to cool them and pick up the necessary heat for the radiator system at the same time. Such a system, supplemented by heat added from the engine exhausts, is used in the comprehensive district heating installation at Schwerin Electrical Works, Germany (*Power,* June, page 285). It provides a convenient method of storing heat for peak loads in the long pipe lines and in auxiliary insulated tanks.

If jacket water is utilized in a closed cooling system, some sort of simple heat exchanger can be utilized to regain the heat. This can be either a purchased unit or a simple home-made double coil, depending upon the proportion of the water heat required.

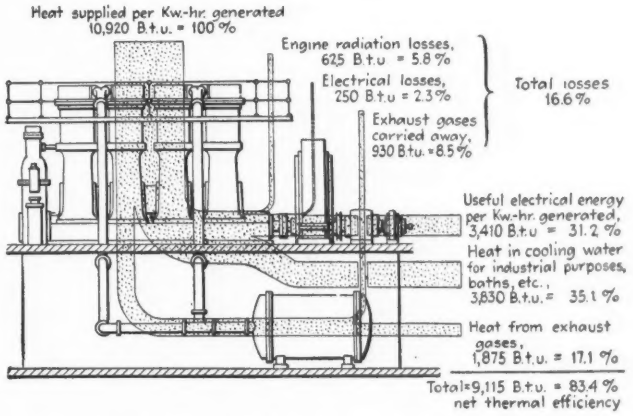

Heat supplied per Kw.-hr. generated
10,920 B.t.u. = 100 %
Engine radiation losses, 625 B.t.u = 5.8 %
Electrical losses, 250 B.t.u = 2.3 %
Exhaust gases carried away, 930 B.t.u. = 8.5 %
Total losses 16.6 %
Useful electrical energy per Kw.-hr. generated, 3,410 B.t.u = 31.2 %
Heat in cooling water for industrial purposes, baths, etc., 3,830 B.t.u. = 35.1 %
Heat from exhaust gases, 1,875 B.t.u. = 17.1 %
Total=9,115 B.t.u. = 83.4 % net thermal efficiency

Fig. 2—Where the heat input goes in a diesel fitted with waste heat recuperator, per kw-hr. generated

Heat recoverable from the jacket water may be determined easily. Assume, for example, a 1,000-hp. engine consuming about 0.42 lb. of fuel per b.hp.-hr. Hourly fuel consumption at full load is 420 lb. If this is 18,000-B.t.u.-per-lb. fuel, and jacket water absorbs 30 per cent of it, then $0.30 \times 18{,}000 \times 420 = 2{,}268{,}000$ B.t.u. available hourly in the cooling water. Allowing 1,000 B.t.u. per lb. of steam, this is equivalent to 2,270 lb. of steam per hr., which if created by coal at a representative heating-plant evaporation of 8 lb. of water per lb. of coal would require 285 lb. of coal per hr. Engines of the most modern type add about 26 B.t.u. per b.hp. per min. to the cooling water, assuming full-load operation. All of the heat may be used without affecting engine performance or increasing fuel consumption.

By adding the waste heat recoverable from the exhaust gases, jacket water temperature may be raised to the boiling point or steam may be produced at pressures from atmospheric to as high as 90 or 100 lb. If the jacket-water heat is being utilized elsewhere or operates in a closed system, the heat in the exhaust gases may be utilized separately for heating hot-air heaters or for heating cold water.

Some form of exhaust-gas heater is necessary. If it

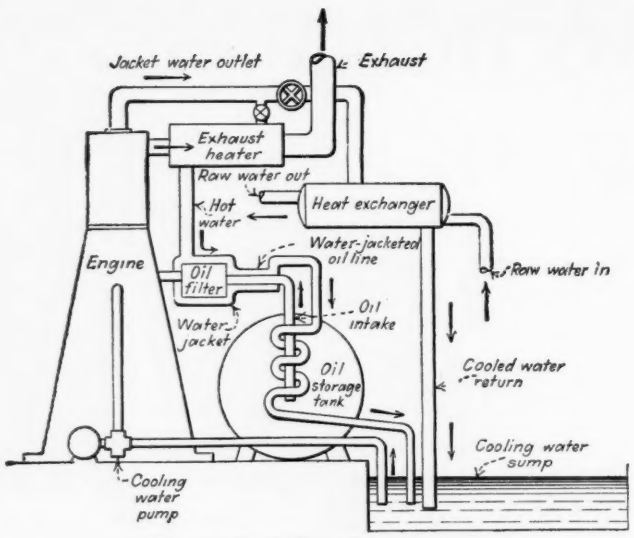


Fig. 3—Fuel-oil preheating set-up

is planned simply to raise water temperature or to produce low-pressure steam at up to 8 or 10 lb. gage, a simple cast-iron heat exchanger can be used. The only requirement is that the discharge of waste gases be not obstructed. One commercial cast-iron heater of this type will, with a 10-hp. engine, heat 45 gal. of water per hr. to 150 deg. F., using exhaust heat only. If jacket water heat is used in conjunction, the figure is increased to 110 g.p.h. Under the same conditions the unit will heat 35 and 80 g.p.h. to 180 deg. and 30 and 70 g.p.h. to 200 deg. F.

A 300-hp. engine will provide 1,350 g.p.h. at 150 deg., 1,050 g.p.h. at 180 deg., and 920 at 200 deg., using exhaust heat only, or 3,140 at 150 deg., 2,500 at 180 deg., and 2,180 at 200, using both exhaust and jacket water heat. If desired, this same heater will produce 5 lb. of steam per b.hp.-hr. at 10-lb. pressure, using both exhaust and jacket water.

If steam at pressures above 10-lb. is desired, a steel-shell boiler is ordinarily used. Such a boiler is usually put in the exhaust pipe, and its design permits it to replace the muffler. This simplifies engine exhaust piping and eliminates valves which might prove awkward in the exhaust line. These boilers, if steam is not desired, can usually be run dry without harm, due to the low temperatures of the exhaust.

In addition to the necessity of avoiding back pressure, the boilers must be tight to keep moisture out of the exhaust gases or the water will cause formation of sulphurous acid, which will corrode the boiler and tube walls. This is particularly dangerous with high-sulphur fuels. For the same reason the boiler should be proportioned so that the exhaust gases will not be cooled below 250 to 300 deg. F. This is to prevent condensation on the gas sides of the tubes, and consequent corrosion and accumulation of carbon, the former eventually causing pitting at the tube ends.

Because of the relatively low temperature of the exhaust gases—say, 500 to 700 deg. F. for a 4-cycle engine—and the necessity of letting the gases leave the boiler at 250-300 deg. F., heat taken from the exhaust is fairly definitely limited. Usually, at full load, a waste-heat boiler should produce a pound to a pound and a half of steam for each brake horsepower produced by the engine. This means that only about 50 per cent of the sensitive heat in the exhaust is normally recovered. Further, for each pound of oil burned, a pound of steam is formed in the exhaust, so at least 1,200 B.t.u. escapes in this steam per lb. of oil. Of course, increasing the pressure at which steam is generated decreases the amount obtainable. Because of these considerations, and the relative first cost of installation, waste-heat boilers are rarely economical on engines of less than 500 hp., or engines which are only for peak-load service, or run at partial load. Exhaust temperatures drop off very

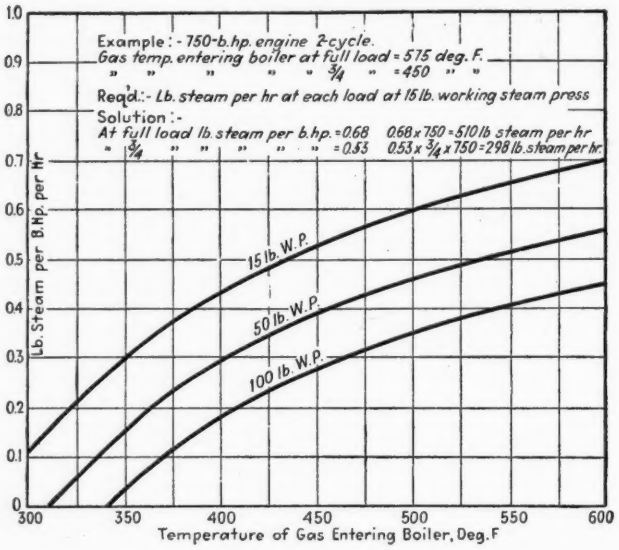

Example:- 750-b.hp. engine 2-cycle.
Gas temp. entering boiler at full load = 575 deg. F.
" " " " " 3/4 " = 450 " "
Reqd.:- Lb. steam per hr at each load at 15 lb. working steam press
Solution:-
At full load lb. steam per b.hp. = 0.68 0.68 x 750 = 510 lb steam per hr
" 3/4 " " " " = 0.53 0.53 x 3/4 x 750 = 298 lb. steam per hr.
Lb. Steam per B.Hp. per Hr
15 lb. W.P.
50 lb. W.P.
100 lb. W.P.
Temperature of Gas Entering Boiler, Deg. F

Fig. 4—Heat recoverable from a 2-cycle diesel in lb. of steam per hr. per b.hp. at 15, 50- and 100-lb. working pressure, with exhaust-gas temperatures of 300-600 deg. F.

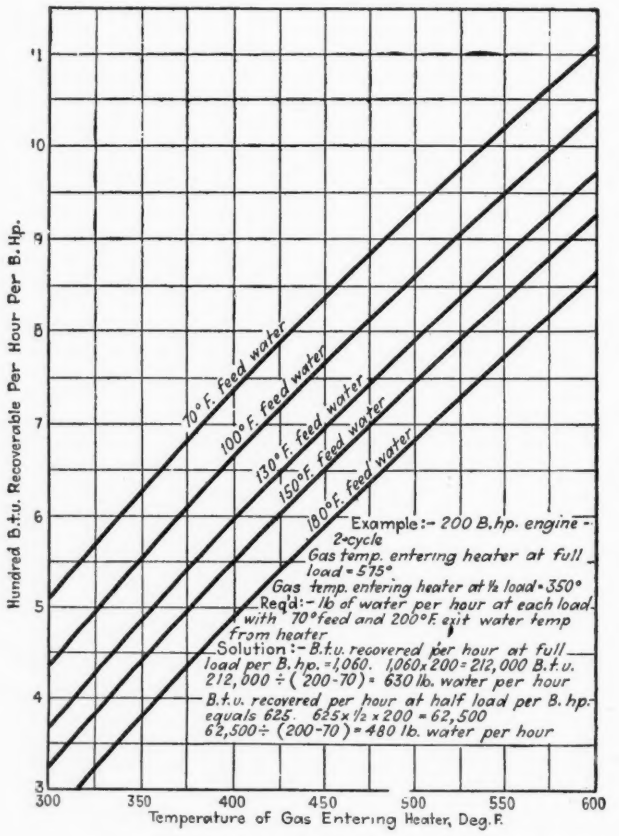

Hundred B.t.u. Recoverable Per Hour Per B.Hp.
70° F. feed water
100° F. feed water
130° F. feed water
150° F. feed water
180° F. feed water
Example:- 200 B.hp. engine - 2-cycle
Gas temp. entering heater at full load = 575°
Gas temp. entering heater at 1/2 load = 350°
Reqd:- lb of water per hour at each load with 70° feed and 200° F. exit water temp from heater
Solution:- B.t.u. recovered per hour at full load per B.hp. = 1,060. 1,060 x 200 = 212,000 B.t.u.
212,000 ÷ (200-70) = 630 lb. water per hour
B.t.u. recovered per hour at half load per B.hp. equals 625. 625 x 1/2 x 200 = 62,500
62,500 ÷ (200-70) = 480 lb. water per hour
Temperature of Gas Entering Heater, Deg. F

Fig. 5—Heat recoverable as hot water from 2-cycle diesel in B.t.u. per hr. per b.hp. with feed-water temperatures of 70-180 deg. F. and exhaust-gas temperatures of 300-600 deg. F.

rapidly as load is decreased, lessening heat recoverable.

Waste heat may also be used to heat air by a simple air heater in the exhaust line. One of the easiest methods is to jacket the silencer and a portion of the exhaust line, and to blow air through this jacket (in a counter-flow direction) and out through louvers into the space to be heated. Such a system is used at Bloomington, Ill. (*Power,* July, page 359). Additional air can be heated or it can be raised to a higher temperature by passing it first over coils in which the heated jacket water is run. Many foreign installations and some American ones use air heaters of the type containing a blower and a series of hot water pipes, the water being jacket water heated by exhaust. With a hot-water system, each hp.-hr. provides heat to raise the temperature of 180 cu.ft. of space from an outside temperature of 4 deg. F. to 60 or 68 deg. F., room temperature.

Such an installation of course shows no profit in summer, but at least reclaims sufficient heat to avoid installation of other heating equipment in the building. If the

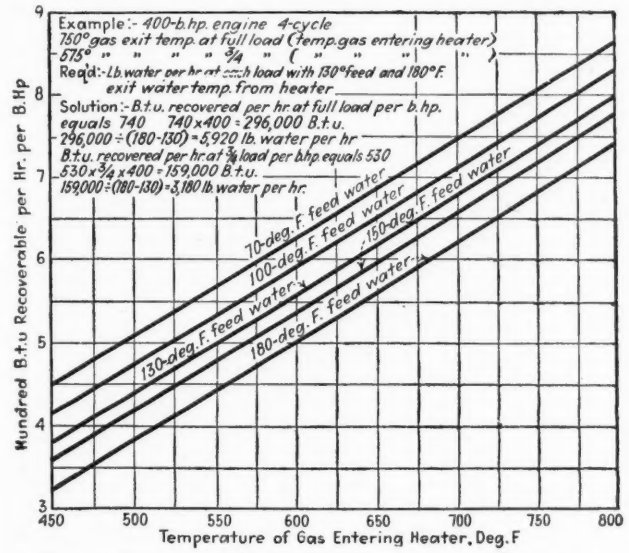

Example:- 400-b.hp. engine 4-cycle
150° gas exit temp. at full load (temp. gas entering heater)
575° " " " " ¾ " (" " " " ")
Reqd:- Lb. water per hr at each load with 130° feed and 180° F. exit water temp. from heater
Solution:- B.t.u. recovered per hr. at full load per b.hp. equals 740 740 x 400 = 296,000 B.t.u.
296,000 ÷ (180-130) = 5,920 lb. water per hr
B.t.u. recovered per hr. at ¾ load per b.hp. equals 530
530 x ¾ x 400 = 159,000 B.t.u.
159,000 ÷ (180-130) = 3,180 lb. water per hr.
70-deg. F. feed water
100-deg. F. feed water
130-deg. F. feed water
150-deg. F. feed water
180-deg. F. feed water
Hundred B.t.u Recoverable per Hr. per B.Hp
Temperature of Gas Entering Heater, Deg. F
3
4
5
6
7
8
9
450
500
550
600
650
700
750
800

Fig. 6—Heat recoverable as hot water from 4-cycle diesel in B.t.u. per hr. per b.hp. with feed-water temperatures of 70-180 deg. F. and exhaust-gas temperatures of 450-800 deg. F.

engine is installed in a plant using quantities of process steam, the heat may be recovered throughout the year, and may even be stored in the form of hot water in insulated tanks if only used periodically.

Particularly in marine installations, where drinking and cooking water must be stored or distilled as needed, and in those stationary installations having open cooling systems, waste heat may be utilized to distill water. Some installations have suitable means of obtaining rainwater, but this may not be sufficient to make up the usual 3 per cent required. In distilling, the water is first led through a heater in the exhaust line and converted to steam at atmospheric pressure, then run through a closed heater in which it is condensed by the cooling water.

It may be raised in temperature before entering the exhaust heater by being passed through the exhaust pot. This will raise its temperature to about 150 deg. The usual rule is to allow about 1 sq.ft. of heater surface per hp. to absorb recoverable waste heat. Engine waste will average 3,000 B.t.u. per hp.-hr.; the heater will pick up about half of this, thus providing about 1½ lb. of makeup water per hour per horsepower.

In colder regions, it is often necessary to heat fuel oil before it will flow from tank cars into storage tanks or from storage tanks into the day tanks in the engine room. Since most tank cars have heating coils of limited capacity, it is almost essential to use steam for heating the tank cars. This may be furnished by a small auxiliary boiler, or better, by a waste-heat boiler.

A suitable coil for heating oil in storage tanks was described in *Power* in November, 1932, page 229. It consists simply of a coil around the oil inlet; thus only the oil entering the intake is heated to the maximum, the great body of oil about it, while heated by convection, still acting as a partial insulator. If a flat coil is

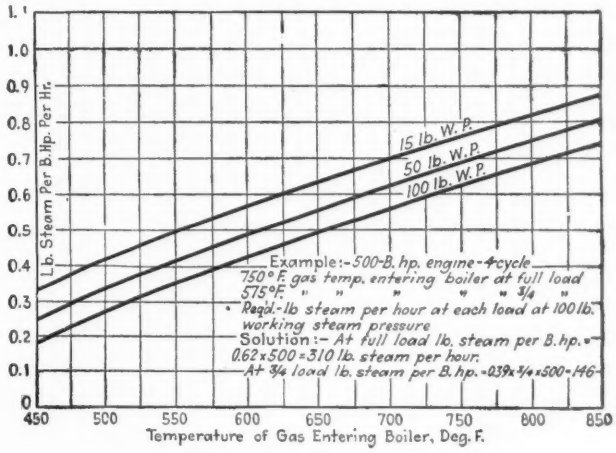


Fig. 7—Heat recoverable from 4-cycle diesel in lb. of steam per hr. per b.hp. at 15-, 50- and 100-lb. working pressure, with exhaust-gas temperatures of 450-850 deg. F.

Figs 4-7 courtesy Edge Moor Iron Co.

preferred along the tank bottom, it should average about 1 sq.ft. of pipe surface to each 50-60 cu.ft. of tank volume. Either steam or hot water heated almost to the boiling point should be used.

Waste heat can also be used to preheat heavy fuels to permit their more efficient combustion. Such a set-up is shown in Fig. 3. This utilizes an oil filter with a hot-water jacket, the hot water being obtained by reheating a portion of the jacket water by means of an exhaust heater. Or if less heat will do the necessary heating, a copper coil in the exhaust pipe will provide hot water to heat the oil pump and inlet or for a water-jacketed oil filter. If raw water is being used in engine jackets, the maximum temperature should be kept below 130 deg. F. Waste heat may also be used as at Rockville Center, N. Y., for cleaning lubricating oil. Oil is pumped into tanks containing steam coils, heated to 180 deg. F. then centrifuged or chemically treated.

There is another use for waste heat which is not extensively understood in this country—for producing power. Some European makers drive the scavenging air blowers on 2-cycle engines by turbines using the exhaust gases. If the steam is regained and used in turbines to generate electricity, about 2 to 3 per cent of the heat energy of the fuel will be regained as electrical energy if the engines are 2-cycle, and perhaps 3 to 4 per cent if the engines are 4-cycle. This obviously is only economical if the particular plant contains steam turbines and could add the steam from the waste-heat boilers to the steam produced by other means, remembering at all times that such steam is only worth the cost of the fuel that would be required to generate it.

PRESSURE REGULATORS

—HOW THEY WORK

By LOUIS H. BRENDEL
Mason Regulator Company

THE subject of pressure regulation and control is very old. Many of the basic principles herein reviewed form the foundation upon which the present-day highly sensitive regulators are built. It is therefore necessary to investigate thoroughly the fundamentals in order to understand why a pressure regulator is built like it is, and why it functions as it does.

Practically all pressure regulators use the principle of a flexible diaphragm, upon one side of which the controlled pressure exerts its force, while this force is opposed by various mechanical means acting on the other side.

Fundamentally, all pressure regulators are divided into two general classifications (Fig. 1). Those in which increased pressure *opens* the valve are called "back-pressure regulators" or relief valves. Those in which increased pressure *closes* the valve are called "reducing regulators."

These two basic classifications are further sub-divided into "direct-acting" and "pilot-operated" types. In the direct-acting type (Fig. 2) the valve stem is firmly attached to a flexible diaphragm. The pressure to be controlled exerts its force on one side of the diaphragm, while weights or springs on the opposite side resist this pressure.

While the direct-acting type regulator is entirely satisfactory for many services, its limitations definitely bar it from certain types of work. These limitations, which made it necessary to develop the pilot-operated type of regulator, are largely the result of the basic principle of direct-acting regulators, namely, that the amount of valve travel is proportional to the load change per pound of controlled pressure exerted on the diaphragm. Obviously, this is limited by the final diaphragm load. The area of the diaphragm is governed by the range of pressure to be controlled. Low-pressure regulators, of course, have much larger diaphragms than do high-pressure regulators.

For example, a regulator operating at 100 lb. has a diaphragm with an area of 20 sq.in. (Fig. 3) while one working at 30 lb. has an area of 63 sq.in. and one at 10 lb. has double the area or 132 sq.in.

Now suppose we increase the control pressure 1 lb. on the 100-lb. regulator. Acting over an area of 20 sq.in., this produces a 20-lb. increase in force opposing the springs. According to Hooke's law, the deflection of any spring is proportional to the load applied. We therefore obtain a valve movement in the 100-lb. regulator proportional to the 20-lb. increase in load on the springs. In like manner, 1-lb. change in the control pressure acting on the 132-sq.in. diaphragm exerts a force of 132 lb. on the springs, and the corresponding proportional spring deflection and valve travel is the result.

The difference between these regulators is further accentuated by the fact that in the 100-lb. regulator the spring or springs must be capable of supporting a load of 3,100 lb., while in the 10-lb. regulator the springs are only required to support a diaphragm load of 1,300 lb. By springs capable of supporting a load of

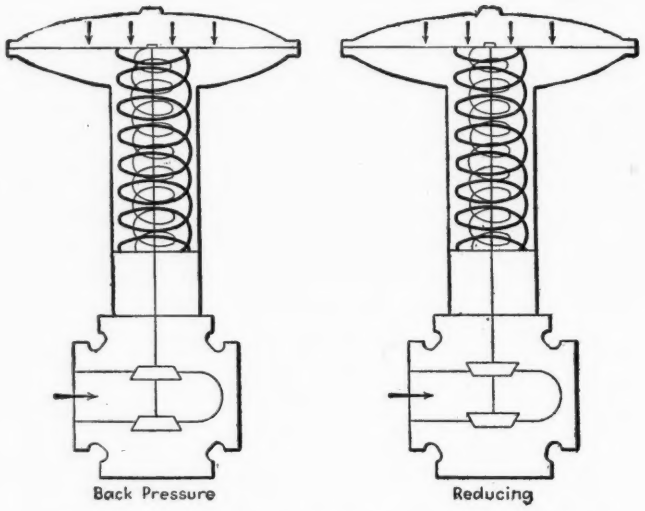


Fig. 1—Increased pressure opens valve in "back-pressure" regulator (left), closes it in "reducing" regulator (right)

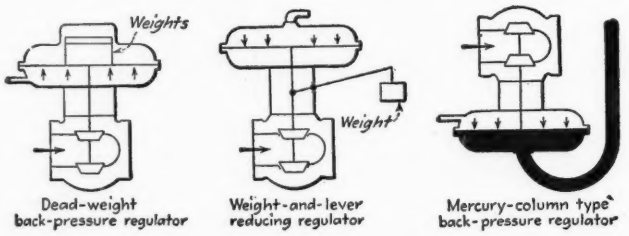


Fig. 2—Three types of direct-acting regulators

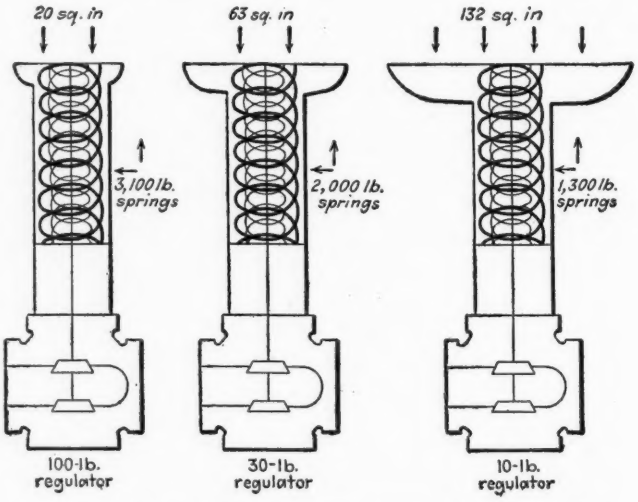


Fig. 3—With direct-acting regulators higher pressure means lower sensitivity. See text for explanation

3,100 lb. we mean a set of springs that require a force of 3,100 lb. to compress the coils until they are all "dead" or touching one another. It follows, therefore, that a 1-lb. change in diaphragm pressure in the 100-lb. regulator will produce a spring deflection of 20/3,100 = 1/155 of the total compressibility of the springs.

Figured in the same way, the fraction is $\frac{1}{3\frac{1}{2}}$ for the 30-lb. regulator and 1/10 for the 10-lb regulator.

Now, since the total compressibility or adjustment of these springs is 3 in., the valve travel from a 1 lb. change in diaphragm pressure will be 0.019 in. for the 100-lb. regulator, 0.094 in. for the 30-lb. regulator and 0.3 in. for the 10-lb. regulator.

Thus a 1-lb. change in diaphragm pressure will produce 15 times as much valve travel in a 10-lb. regulator as in a 100-lb. regulator. Or if we consider pressure, we see that it is necessary to increase the controlled pressure on the diaphragm of the 100-lb. regulator 15 lb. in order to open the valve as much as the 10-lb. regulator valve opens on a 1-lb. increase.

These limitations of direct-acting regulators are the same whether springs or a weight and lever are utilized to provide the diaphragm resistance. They are inherent.

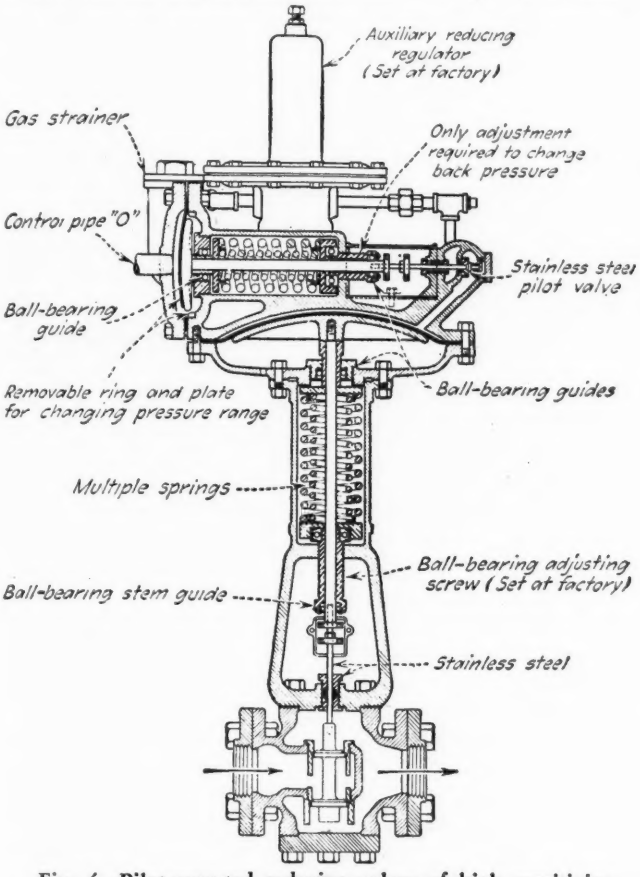


Fig. 4—Pilot-operated reducing valves of high sensitivity can be designed for any pressure

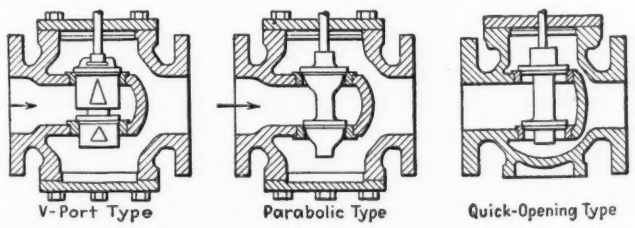


Fig. 5—Balanced valves designed for gradual opening (A and B) and quick opening (C)

From the three examples studied it becomes apparent that as we go to higher pressures in direct-acting regulators we may anticipate even greater pressure variation at such times as the valve must be opened to near the maximum capacity.

As modern industry advanced into higher pressures, the pilot-operated type of regulator (Fig. 4) was perfected. This consists of a regular direct-acting regulator whose diaphragm operating pressure is supplied by a pilot valve. This pilot valve, in turn, is operated by the pressure which is being controlled. In this manner, a mere fraction of a pound pressure variation on the pilot-valve diaphragm is ample to actuate the pilot valve sufficiently to permit the operating air or gas or water to exert its force on the main diaphragm.

From this comparison, it may seem that the performance of the direct-acting regulator is far inferior to that of the pilot-operated type. This is certainly true in some respects, although there are many cases where the simpler type provides satisfactory regulation. For example, for pressures below 10 lb., the direct-acting type is generally preferred.

For pressures above 50 lb., where large varying volumes must be handled with a very small allowable pressure variation, a pilot-operated regulator should generally be used.

A direct-acting type will still be found highly efficient for handling fairly constant volumes up to 150 lb. For pressures above 150 lb., a pilot-operated type of regulator is normally desired to insure close regulation.

In the design of the valves or poppets, we find two general classifications, "quick-opening" and "gradual opening" (Fig. 5). The former is by far the most common in regulators, although there is a growing demand for gradual-opening valves wherever close throttling is desired. Gradual-opening valves find their greatest application in services where the rate of flow varies greatly.

Rapidly changing plant processes have brought another factor into primary importance. This is the ability to convert, economically, regulators of one pressure range into other pressure ranges. This is accomplished by making it easy to remove the springs and substitute another set and to use diaphragms of different areas.

As in the automobile industry, each new regulator model becomes more foolproof. Tampering by unauthorized persons is minimized by enclosing adjusting screws and other moving parts.

Practically all regulators are made with what are known as balanced valves. That is, the valve has two ports and the valve has an upper and lower valve disk of almost exactly the same area. This permits the valve plug to operate easily, regardless of the line pressure flowing through the valve body. Regulators should be installed in the line so that the fluid flows into the bridge between the upper and lower valve disk.

There is one drawback, however, to the balanced type of valve when a metal valve is seated against metal seat rings. This is caused by the difference in the expansion of the valve and the valve body. In other words they might be ground in so as to give a tight seating at one temperature but if the temperature varies, then the valve itself might expand at a different rate than the valve body, causing the valve to permit a slight leakage at this new temperature. It has, therefore, been found, for dead-end service where the temperatures are apt to vary, that a single seated valve or even a valve with a composition seat is necessary to prevent leakage.

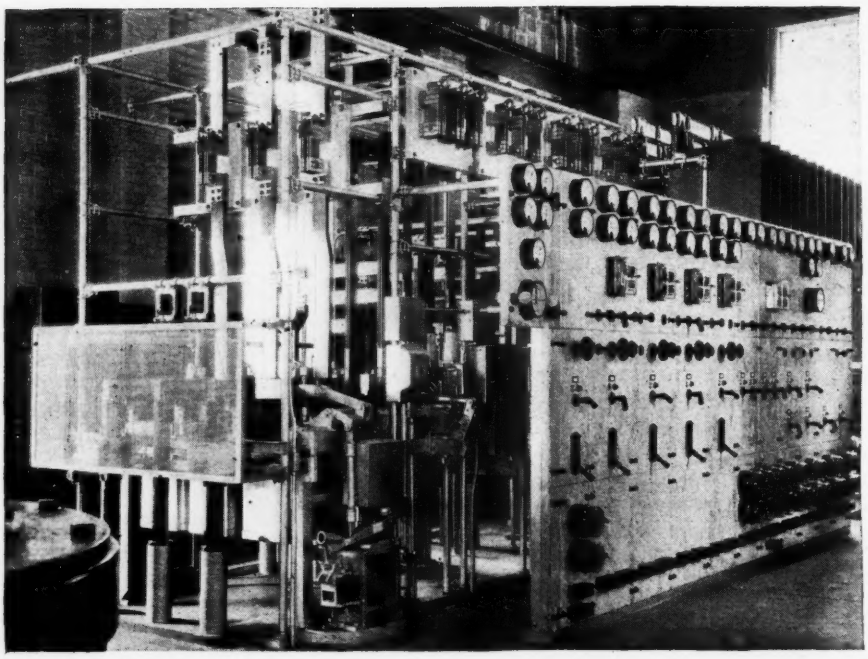


Fig. 1—New switchboard and bus structure that replaced live-front manually operated board

As told by the superintendent of the electrical department to FRANCIS A. WESTBROOK, *consulting engineer*

Improved operation resulted when the Vermont Marble Co. tried

REVAMPING POWER EQUIPMENT

To Keep Engineers on the Job

TRUE to Vermont traditions of thrift and foresight, when the present business depression began the Vermont Marble Company had means available to undertake an extensive modernization program. This work has kept many workers on the payroll who might otherwise have been laid off, and the reconstruction has greatly improved operating conditions. Modernization of the switchboard at the company's hydro-electric station at Proctor, Vt., an interesting job, has just been completed.

The four vertical-shaft units in the plant, one rated at 1,600 kva. and three at 800-kva., all operate at 480 volts. Three of the generators are shown in the foreground in Fig. 2, the main floor of the power house, the main power switchboard is in the rear at the left and the distribution board at the right.

This station supplies power for extensive shops at Proctor and for operations in several other towns. In addition, current is supplied for street and domestic service in Proctor. This station has been in operation for many years, and much of the equipment was out of date, especially the switchboard and transformers.

The old switchboard was a live-front manually operated type dangerous to work around. To tie in this station with the other plants it was necessary to throw two 3,000-amp. knife switches at a time. By exercise of great care when throwing these switches, no accidents have occurred.

The switchboard presented several conditions that needed changing, and the slack period when the electrical department was not busy with routine work was the time to do it. No extra men were employed and no attempt was made to rush the job, so that the electrical department could be kept intact. A good deal of other work was held in abeyance when not urgent and allowed to accumulate, so that when the men had completed the power-house job there was other work available to keep them busy for several months.

The new switchboard, Fig. 1, is of the remote-control dead-front type. The 480-volt buses and oil switches are in the foreground. Buses for 11,000 volts and the switches are in the background. On account of space limitations the 11,000-volt knife switches were placed so close together that it was advisable to install Bakelite barriers between them, as shown above the right-hand end of the switchboard.

It is probable that in the not-distant future, two old 800-kva., 480-volt generators will be replaced with one 1,600 kva., 11,000-volt machine. For this reason one of the oil switches for an 800-kva., 480-volt generator is of a capacity to handle the proposed new generator. It has been installed adjacent to the existing 11,000-volt switches. Although there is extra space between the two groups of switches, it will only be necessary to move the 11,000-volt switch two or three feet to one side to make it a part of the high-voltage group.

At the right in Fig. 2 are oil switches and bus structure to supply 480-volt service to the local shops at Proctor, the oil switches being controlled from the main board. The generator nearest to the 480-volt switches

is wired so that it may be connected directly to this bus in case it is desirable for any reason to cut the main switchboard dead.

The old power transformers are in the basement. Their losses are excessive according to modern standards, and, as more capacity was needed, new transformers were installed outside the power house. A concrete platform has been provided for the transformers. In case of a flood similar to the one of 1927, special precautions have been taken to make the transformers waterproof.

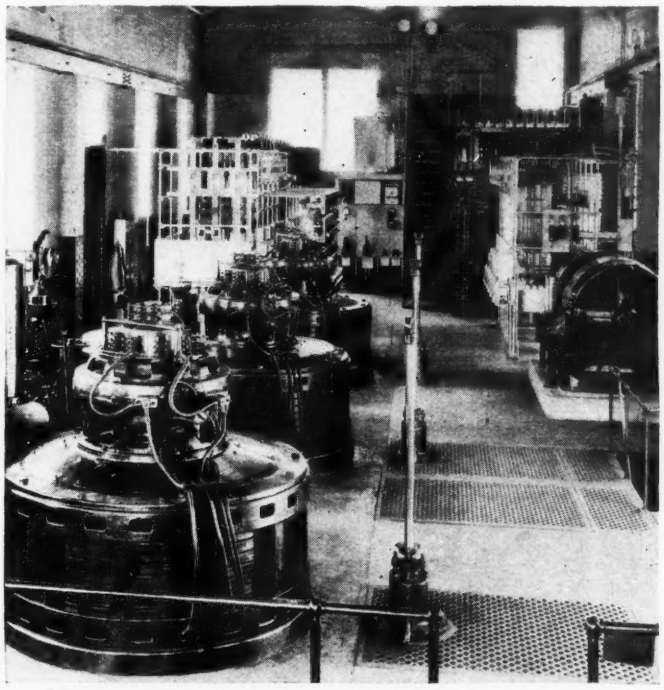


Fig. 2—Interior of the hydro-electric plant, showing three 800-kva. units; a 1,600-kva. unit in the plant is not shown

These three transformers are each rated 500 kva., 60 cycles. They have oil-filled terminal chambers on opposite sides of their tanks for both the low-and high-tension leads, and the cable sheaths have been wiped to the water-tight pot-heads to make waterproof joints. All joints in the transformer cases have been welded.

Each of these transformers is provided on the high-tension side with three 2.5 per cent taps above 11,000 volts for full transformer capacity. Each transformer also has an externally operated ratio adjuster, suitable for operation when the transformer is disconnected from the line. A dial thermometer, an oil discharge valve with plug, oil-sampling cock, oil-level gage and three oil- filter connections with valves and plugs are also provided on each transformer. Of the oil-filter connections one is at the top and two are at the bottom on opposite sides of each transformer. One of the lower ones is a foot above the lowest point of the tank and the other as near the low point as possible.

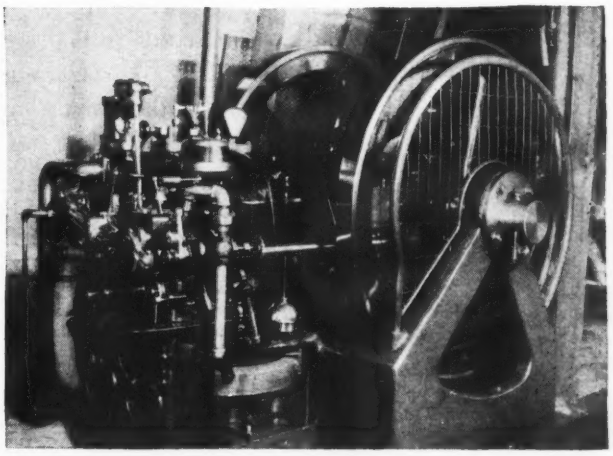
It will be necessary at times to use both the old and the new banks of transformers. As they have very different characteristics, it has been felt necessary to provide the old ones, which are also of 500-kva. capacity, with reactances in order that the load may be properly divided between them and the new transformers.

A water-level indicator, in top center Fig. 2, is another improvement made in the power house. The indicator shows the elevation of the water at the dam, which is some distance away and out of sight of the station. This is a great convenience at times of low water when the amount of water available has to be carefully checked. Forebay water levels were formerly obtained by sending a man up to the dam every hour or so when conditions were serious.

MODIFIED GAS ENGINE OPERATES AS DIESEL

A SECOND-HAND, $6\frac{1}{4}$x$13\frac{1}{2}$-in. Otto gas engine, a knack for mechanics and a lot of ingenuity have been combined to produce a diesel engine by George C. Green of Lambertville, N. J. He uses it to supply power for his machine shop all year 'round, and to help heat the shop in winter. Mute testimony of its mechanical excellence is its performance record—nine hours operation every working day for three years, developing 8 hp. at 320 r.p.m. at an average cost of less than 20 cents a day for fuel and lubricating oil.

A 5-in. sleeve was inserted in the $6\frac{1}{4}$-in. cylinder, and a new piston and head added. Intake and exhaust valves are located as in the gas engine, and the injection nozzle substantially where the spark plug was. Fuel pump and injection nozzle are one unit, cam driven. The $\frac{3}{8}$-in. diameter by $\frac{5}{16}$-in. stroke fuel-pump plunger is a lapped fit without packing, and the spring loaded nozzle, of the Dornier type, throws a cone-shaped spray. Injection pressure is about 2,000 lb. per sq.in. Governing is accomplished by controlling the time of opening the fuel-pump bypass valve. The shaft, which, in addition to the double flywheel, carries a friction clutch and pulley for



driving the shop lineshaft, has been reinforced with outboard bearings. Starting is by compressed air.

The lubricating system includes a home-made belt-driven centrifugal separator which works continuously. City water, controlled by thermostat, is used for engine cooling, and supplies some of the heat for the building in the winter.

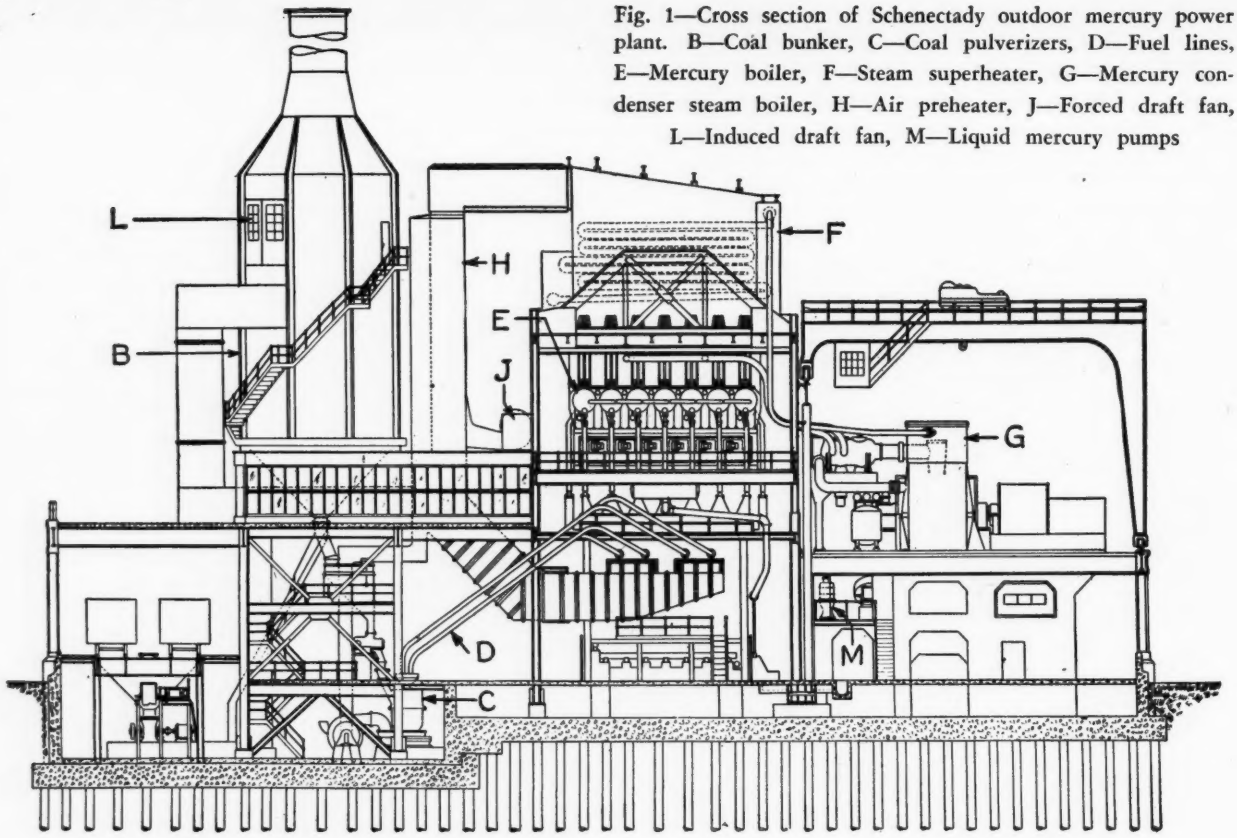


Fig. 1—Cross section of Schenectady outdoor mercury power plant. B—Coal bunker, C—Coal pulverizers, D—Fuel lines, E—Mercury boiler, F—Steam superheater, G—Mercury condenser steam boiler, H—Air preheater, J—Forced draft fan, L—Induced draft fan, M—Liquid mercury pumps

G. E. CO-ORDINATES
Industrial Steam and Utility Power

By A. R. SMITH
General Electric Co.

This, an abstract of a paper presented at the recent World Power Conference, deals with the analysis of steam and power demand which led up to the installation of the mercury-vapor steam power plant at Schenectady

THE Schenectady factory has one steam plant which was constructed 38 years ago and a second one of twice the capacity which is 25 years old. It was found necessary to provide new steam generating facilities and to consider the immediate retirement of the first plant and later to abandon the second.

This required immediate provision for 400,000 lb. of steam per hr. at 200 lb. pressure and 525 deg. temperature, and 25,000 kw. of 60-cycle power. Ultimately, there will be required 900,000 lb. of steam per hr., at 200 lb. pressure and 55,000 kw.

Studies were prepared to determine whether this 400,000-lb. steam load should be produced at 200 lb. pressure with no byproduct power recovery or if it should be produced at some higher pressure or by means of a mercury cycle. One of the difficulties in analyzing this situation is the different characteristics of the electrical load and the steam demand. The electrical load has a predominating daily characteristic while the steam demand has a predominating seasonal characteristic.

Table I shows how much electric energy could be produced from a factory steam demand of 400,000 lb. per hr. at 200 lb. pressure, with turbine-generator efficiency of 80 per cent. The introduction of an evaporator for the 600-lb. proposition made that cycle less attractive than the 400-lb. cycle, and the mercury power production possibilities were found to be far in advance of those of the other cycles studied.

Graphs were prepared to show the factory steam and electric power requirements from January 1 to December 31. These graphs, shown in Fig. 2, also indicate the possible output from a mercury-vapor plant. The factory requirements of steam and electricity are segregated for the working day, for the remainder of the working day (that is, nights) and for holidays and Sundays. The scale at the bottom of these graphs, instead of measuring 8,760 hr., is reduced by 20 per cent, during which time it is assumed that the most important equipment may be out of commission.

These graphs show that during the year the present existing steam plant would be required to supply 164,360 lb. of steam. The mercury boiler would supply 1,538,760 lb. and the steam boiler 1,239,000 lb. All of the electric energy required by the General Electric Co. would be supplied by the mercury turbine in amount of 70,000 kw.-hr. The remaining 92,455 kw.-hr. generated by both the mercury and the steam turbine, is available for utility power company use.

Steam Conditions						
Initial		Entering Evap.		Exhaust		
Press. lb. per sq.in.	Temp. Deg. F.	Press. lb. per sq. in.	Temp. deg. F.	Press. lb. per sq.in.	Temp. deg. F.	Kilowatts
200	525	No Evap.	....	200	525	.....
400	750	No Evap.	....	200	625	5,970
600	750	400	670	200	Sat.	5,150
1,200	750	400	518	200	Sat.	13,750
2,400	1,000	400	618	200	625	24,050
125 Hg. Vapor		28 in. Vac.		200	625	42,200

Equipment now installed in the mercury-vapor power plant in Schenectady consists of one steam boiler capable of producing 325,000 lb. of steam per hr. at 400 lb. pressure and 750 deg. temperature, the mercury boiler and turbine capable of producing 20,000 kw. and 325,000 lb. of steam per hour, and a non-condensing steam turbine generator for operating between 400 lb. and 200 lb. per sq.in. and capable of producing 6,000 kw. The plant, therefore, has a capacity of 26,000 kw. and 606.000 lb. of steam per hr.

Fig. 3 shows an elevation of the mercury boiler. The *mercury* side walls are shown extending from below the porcupine tubes for a distance of 15 ft. They consist of three steel tubes imbedded in copper in a calorized steel armored channel.

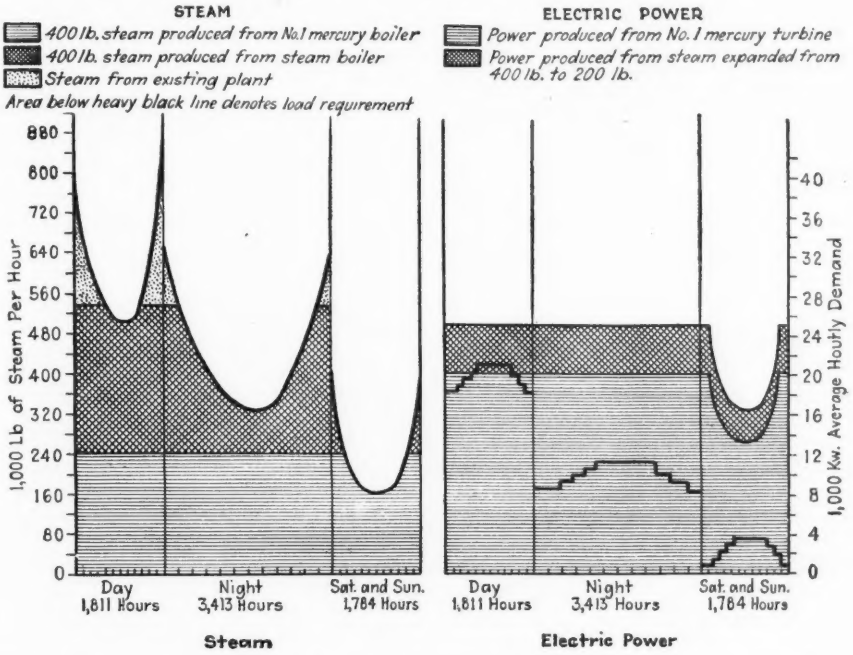


Fig. 2—Heavy lines show steam and power required by factory

There are seven seamless steel drums into which the mercury porcupine tubes have been welded. Between the drums are located the mercury liquid heaters, which are similar to steaming economizers.

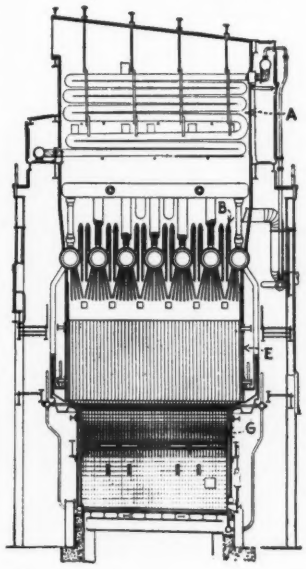
The furnace bottom and sides for a height of 15 ft. are *water* cooled with block-covered tubes, which is the usual B. & W. construction for slag-top furnaces. The 400-lb. steam produced in the lower section of the furnace amounts to 85,000 lb. per hr, and is superheated to 750 deg. in a convection superheater placed above the boiler. The 400-lb. steam produced in the mercury condensers amounts to 240,000 lb. per hr.

Mercury turbine is a double-flow, five-stage, 20,000-kw. unit designed for 125 lb. mercury pressure at the throttle and exhausting at 27.5 in. vacuum referred to a 30 in. barometer. Unlike the Hartford installation, the mercury turbine is at the usual turbine floor level, and the mercury is delivered back to the boiler drums by means of a centrifugal pump. The pumping horsepower to return the mercury liquid to the boiler against 125 lb. per sq.in. pressure is only about one-fifth the horsepower that would be required to return the condensate to a 1,200 lb. steam boiler of equal capacity. The pump has a single-stage overhung impeller of 11-in. diameter running at 1,800 r.p.m.

Indoor steam plants have many inherent faults, and, while correct design may eliminate them, one can hardly point out a single station that is completely free of them.

There are, for example, the possible condensation of moisture in the turbine room, disastrous effect of an oil fire and explosion hazard from coal dust, the panic of operators in the event of ruptured steam main, the freezing of water lines because of cold air blowing in windows, gaseous air in the boiler room resulting from the difficulties of proper ventilation, etc. No claim is made that this outdoor plant avoids all such faults, and as a matter of fact the apparatus which requires most maintenance, attention and operating supervision has been suitably protected.

Fig. 3—Elevation of mercury boiler showing steam superheater A, liquid mercury heaters B, mercury walls E, and water walls G



There are many things which do not need housing, such as coal bunkers, floors, fans, air preheaters, superheaters, feedwater heaters, de-aerators, evaporators, and large boilers (where a large share of the repairs are made from within) can just as well have their casing waterproofed.

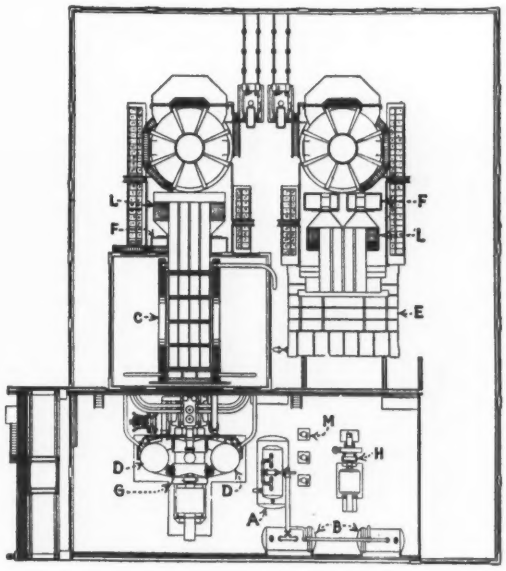
The purpose of housing the coal-unloading facilities was to permit the thawing out of coal cars in winter and to confine the coal dust on account of the close proximity of the steam plant to the factory.

Study of the load chart reveals that byproduct power can be made from the steam load when it cannot be used by the factory. This is one reason for the utility taking over the plant operations and using this excess high thermal efficiency power in its system. Once a utility takes over the management, operation becomes simplified by referring to the steam as a by-product instead of power. In this particular case, the utility leases the plant on the basis of the fixed charges on the actual investment. It is recognized that a plant having a capacity of 26,000 kw. has a certain value per kw. of capacity to the utility, and the fixed charges on this sum are credited to the General Electric Co. This amount is less than the rental, because the actual cost of plant provided for not only production of 26,000 kw. but also 660,000 lb. of steam.

The utility also allowes a credit for each kw.-hr. produced by the plant, all of which goes into its system. This credit is based on the prevailing cost of producing power with modern plant supplying the system, taking into account the fact that the utility must always accept the power produced according to the steam demand, regardless of hour or season.

The power required by the General Electric Co. is sold to them at schedule rates regardless of this agreement, and the excess cost covering the rental, operation and maintenance and the fuel over and above the two credits allowed is charged to the General Electric Co. as the cost of steam.

Fig. 4—Plan showing A—deareator, B—evaporators, C—steam superheater, D—mercury condenser, E—steam boiler, F—forced draft fan, G—mercury turbine, H—steam turbine, L—air heaters, M—feed water heaters



AN ECONOMIC COMPARISON OF BY-PRODUCT POWER CYCLES

By M. W. BENJAMIN and R. G. FELGER

This study, presented at the annual meeting of N.D.H.A., in Chicago, indicates that in the future development of district heating and electric generating plants serious consideration should be given to combining investments by a properly chosen thermal cycle

THE high thermal economy of generating electricity as a by-product of district heating is so attractive that it frequently is asked why by-product generation is not used more extensively in the district heating industry.

If by-product generation is to be worth while, it is not only necessary to have a market for the electricity produced, but it must also replace power which would otherwise be generated under condensing operations.

Duplication in the power-house of the heating-plant electric generating equipment can be eliminated by adding condensing equipment to the by-product cycle. The addition of a low-pressure section and condenser not only makes the electric capacity in the heating plant available the year round, but also materially increases the capacity.

If the heating plant were located on the banks of a river or lake, a conventional condensing machine could be used. For heating plants located a considerable distance from an ample source of cooling water, it is suggested that a special turbine exhausting to a two-stage condenser be used. In such a unit, one-half of the steam would be condensed at absolute pressure of, say, 4 in. of mercury, and the other half at 2 in. This arrangement would permit a temperature rise in cooling water about five or six times that in a water-side power station. The increased temperature rise results in a greatly reduced flow of cooling water and a cooling tower, under these conditions, becomes practicable.

The amount of electricity produced by a turbo-generator depends upon the product of the weight of steam flowing through the turbine and the heat drop in the turbine. The weight of steam flowing is fixed by the load on the heating system and the method employed for heating boiler feedwater. Any by-product cycle, which through extraction will increase the ratio of throttle flow to steam sent out, will generate more electricity than a simple cycle, with a small proportionate increase in coal consumption for the added electric generation.

Various schemes have been proposed for increasing the amount of by-product power generated; some by increasing the weight of steam flowing, some by increasing the heat drop by increasing the initial pressure and temperature, and some by increasing both the flow and heat drop. The more important cycles studied in this comparison are:

Scheme 1. No generation of electricity

The simplest possible arrangement for supplying district heating steam requires a boiler house with suitable steam connections to the distribution system. In setting up comparisons it was assumed that boiler pressure for such a plant would be 145 lb. per sq. in.

Schemes 2 and 3.
Turbine exhausting to plant header

For Scheme 2, the boiler pressure is assumed at 400 lb. per sq. in., with sufficient superheat to provide dry saturated steam at 145-lb. pressure in the turbine exhaust. Such a unit could operate at full capacity whenever the heating load on the plant will permit. In Fig. 1, a two-stage condensing turbine is added to this cycle, making the generating capacity of the station available the year round.

Scheme 3 is the same as Scheme 2, except that the boiler pressure is 600 lb., with a correspondingly higher steam pressure. It would have the same steam flow, but would result in greater electric output because the heat drop through the turbine is greater.

Scheme 4. DeSmaele cycle[1]

The object of this cycle is to increase the amount of by-product power by combining increased steam flow with increased heat drop, due to high initial pressure and reduced back pressure.

Steam generated at 600 lb. pressure and 825 deg. F. is delivered to a turbine where it expands and does work. At a point in the turbine where the pressure is 250 lb. per sq. in. steam is extracted to an evaporator which produces saturated steam at 145 lb. per sq. in. for delivery into the heating plant header. Water for evaporation is heated in three stages by steam bled from the turbine at lower pressures, as indicated in Fig. 2, which shows the cycle with a condensing unit added. All steam going through the turbine would be condensed and returned to the high-pressure boiler, and steam sent to the heating mains would be evaporated from raw or treated city water. This feature of retaining the pure condensate is one of considerable operating importance.

Scheme 5.
Mercury-vapor-steam binary cycle

The object of the mercury-vapor-steam cycle is to increase the amount of heat available for work within reasonable

[1]This cycle was proposed for central heating service in Detroit by Dr. A. DeSmaele of Brussels, Belgium.

Fig. 1—Turbine exhausting to district heating system with two-stage condensing unit added

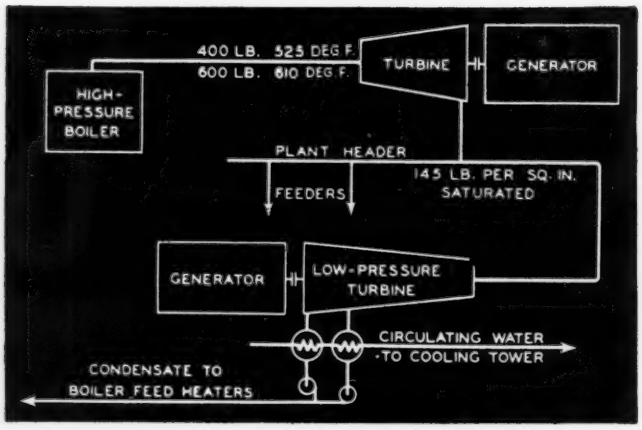
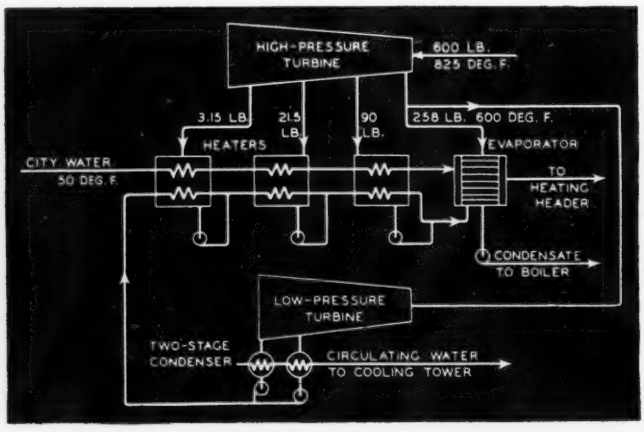


Fig. 2—DeSmaele cycle for generating by-product power with two-stage condensing unit added



pressure and temperature limits. The mercury is evaporated at 80 lb. per sq. in., and a corresponding temperature of 900 deg. F. The mercury vapor in condensing is used to generate steam at 350-lb. pressure, thereby conserving what would ordinarily be the condenser loss in the mercury turbine. The steam is allowed to expand through a turbine from 350 lb. to 145 lb. per sq. in., at which pressure it exhausts to the heating plant.

The table gives an economic comparison of the cycles studied. The ideal condition in which additional steam and electric capacity are required at the same time should be cared for with a by-product cycle in conjunction with a low-pressure condensing unit, in which case the investment in a by-product plant would be less than that for separate heating and power plants, and at the same time the operating cost would be a great deal less. For a by-product plant with a condensing section it appears that either Scheme 3 or 4 offers the greatest commercial advantage.

Where the electric load requirements do not call for additional turbo-generator capacity, the justification for a by-product cycle is not so obvious. However, if electrical capacity is needed, and the by-product unit can be credited with the operating saving over generation in the power station, plus the saving of fixed charges on the equivalent generating capacity in a power-house, it appears that a gross return of 15 to 20 per cent can be realized on the additional cost of the by-product plant as compared with the cost of a simple heating plant. These returns would fall to about 5 per cent on the difference in cost between a combination plant and a central heating plant if conditions are such that no credit for generating capacity could be given by the electric utility.

Data in the table show that byproduct generation is not attractive if the electricity so produced is valued at only the operating saving, $53,620 per year, over the cost of producing an equal amount in a condensing electric station. The additional investment brings in but a small annual percentage return, $\frac{53,620}{2,035,000} = 2.64$ per cent. It is only when full advantage is taken of the ability to assume a proportionate share of the system electrical peak that the combination is extremely profitable, but credit for sharing the system peak cannot justly be allowed unless the electrical equipment in the heating plant does, in fact as well as in theory, take the place of equipment in the electrical plant. The electrical generating plant must truly be smaller and less costly in proportion to the peak-carrying capacity transferred to the heating plant.

If advantage can be and is taken of the peak-sharing ability of the by-product cycle, and no duplication of investment is incurred the economic conclusion will be extremely favorable. Not only is there a large investment saving by combining the functions of steam and electricity production, but there is also a substantial operating saving. This becomes apparent when the figures for the combination plant of Scheme 4 are compared with the steam plant of Scheme 1, plus an electric power plant having the same generating capacity as Scheme 4. The comparative data are:

Production Cost, Dollars Per Year		
Separate Plants —		
Electricity.....	$406,630.00	
Steam.....	117,600.00	
		$524,230.00
Combined Plant.....		470,610.00
Saving resulting from combination....		$53,620.00
Investments		
Separate Plants —		
Electric plant.....	$2,640,000.00	
Heating plant.....	665,000.00	
		$3,305,000.00
Combined plant.....		2,700,000.00
Saving resulting from combination....		$605,000.00

It is thus evident that the by-product plant with a condensing section saves $53,620 per year in production cost as compared with the cost of producing equal services in separate plants, and at the same time requires an investment $605,000 *less* than that for separate plants.

Further examination of the table shows that if the combination plant of Scheme 5 be considered as producing steam as a by-product, it delivers, for $63,980, steam which would cost $200,725 if produced in a simple heating plant. This possible saving of $136,745 per year requires an investment only $60,000 greater than that for a power station of equal electric capacity. On the other hand, if the combination plant be considered as producing electricity as a by-product, it delivers, for $353,010, electricity which would cost $736,630 if produced in a modern power station. This possible saving of $383,620 per year requires an investment of $2,035,000 greater than that for a simple heating plant of equal steam capacity.

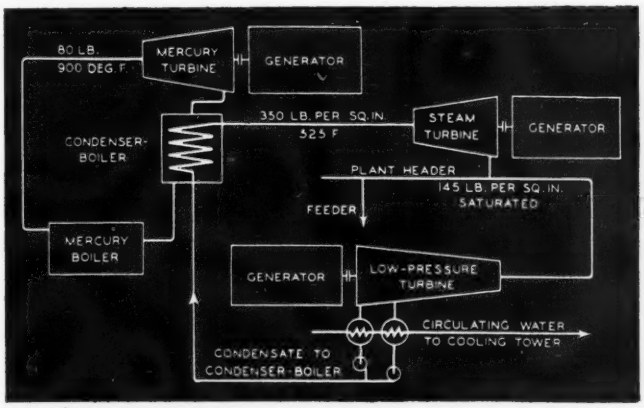


Fig. 3—Mercury-vapor cycle

Scheme Number and Initial Steam Conditions	1— 145 lb sat	2— 400 lb 525 F		3— 600 lb 610 F		4— 600 lb 825 F		5— Mercury vapor-steam	
Condensing Unit Installed	No	No	Yes	No	Yes	No	Yes	No	Yes
1. Maximum steam capacity, lb per hr	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
2. Additional heating load, M lb per yr	502,000	502,000	502,000	502,000	502,000	502,000	502,000	502,000	502,000
3. Coal for additional heating load, tons per yr	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700	26,700
4. Steam output of cycle, M lb per yr	502,000	1,146,400	1,146,400	1,146,400	1,146,400	1,146,400	1,146,400	1,146,400	1,146,400
5. Electric generating capacity of by-product system, kw	—	6,660	6,660	9,690	9,690	13,530	13,530	33,640	33,640
6. Electric generating capacity of condensing turbine, kw	—	—	20,500	—	20,500	—	27,000	—	18,460
7. Total electric generating capacity installed, kw	—	6,660	27,160	9,690	30,190	13,530	40,530	33,640	52,100
8. Total electrical output, kw-hr per yr	—	25,400,000	107,000,000	36,900,000	118,900,000	51,600,000	153,300,000	109,000,000	193,700,000
9. Electrical output of by-product system, kw-hr per yr	—	25,400,000	25,400,000	36,900,000	36,900,000	51,600,000	51,600,000	109,000,000	109,000,000
10. Plant heat rate of by-product system, Btu per kw-hr	—	4,950	4,950	5,050	5,050	5,100	5,100	4,920	4,920
11. Coal for electrical output of by-product system, tons per yr	—	4,840	4,840	7,160	7,160	10,120	10,120	20,650	20,650
12. Electrical output of condensing turbine, kw-hr per yr	—	—	81,600,000	—	82,000,000	—	101,700,000	—	84,700,000
13. Plant heat rate under condensing operation, Btu per kw-hr	—	—	15,700	—	14,500	—	13,600	—	10,700
14. Coal for electrical output under condensing operation, tons per yr	—	—	49,300	—	46,700	—	53,100	—	34,800
15. Total coal for added heating load plus electricity, tons per yr	26,700	31,540	80,840	33,860	80,560	36,820	89,920	47,350	82,150
16. Annual cost of coal at $4.00 per ton, dollars per yr	106,800	126,160	323,360	135,440	322,240	147,280	359,680	189,400	328,600
17. Production cost other than coal, dollars per yr	10,800	29,740	73,330	36,880	81,500	52,770	110,930	85,760	140,670
18. Total production cost in heating plant, dollars per yr	117,600	155,900	396,690	172,320	403,740	200,050	470,610	275,160	469,270
19. Increase in production cost over scheme 1, dollars per yr	—	38,300	279,090	54,720	286,140	82,450	353,010	157,560	351,670
20. Estimated investment, dollars	665,000	1,242,000	2,029,000	1,341,000	2,099,000	1,773,000	2,700,000	6,300,000	7,130,000
21. Additional investment over scheme 1, dollars	—	577,000	1,364,000	676,000	1,434,000	1,108,000	2,035,000	5,635,000	6,465,000
22. Investment for electric generating capacity, dollars per kw	—	86.60	50.40	69.80	47.50	81.90	50.15	211	124.10
23. Reduction in fuel burned in condensing power station, tons per yr	—	12,300	51,800	17,900	57,600	25,000	74,300	52,900	93,900
24. Value of power station fuel saving at $4.00 per ton, dollars per yr	—	49,200	207,200	71,600	230,400	100,000	297,200	211,600	375,600
25. Reduction in production cost other than fuel at power station, dollars per yr	—	17,580	73,330	26,160	81,500	36,530	109,430	90,830	140,670
26. Total reduction in power station production cost, dollars per yr	—	67,180	280,530	97,760	311,900	136,530	406,630	302,430	516,270
27. Net saving in production cost due to electric generation in heating plant, allowing no investment credit for electric generating capacity, dollars per yr (item 26 minus item 19)	—	28,880	1,440	43,040	25,760	54,080	53,620	144,870	164,600
28. Gross return on additional investment over scheme 1 (item 27 divided by item 21), per cent	—	5.0	0.1	6.4	1.8	4.9	2.6	2.5	2.5
29. Estimated investment in power station for electric generating capacity of item 7, dollars	—	433,000	1,765,000	630,000	1,962,000	880,000	2,640,000	1,736,000	5,385,000
30. Net saving in production cost due to electric generation in heating plant, allowing 12½ per cent fixed charges on cost of equivalent power station generating capacity, dollars per yr	—	83,005	222,065	121,790	271,010	164,080	383,620	361,870	387,725
31. Gross return on investment of item 21, based on net savings	—	14.4	16.2	18.0	18.9	14.8	18.8	6.4	9.1
32. Investment in heating plant electric generating equipment minus estimated investment for equivalent generating capacity in condensing power stations, dollars (item 21 minus item 29)	—	144,000	—401,000	46,000	—528,000	220,000	—605,000	3,899,000	5,080,000
33. Gross return on investment of item 32, based on net savings	—	20.0	—	93.4	—	24.6		3.7	5.4

Proper Wire-Rope Lubrication

Lubricates and Protects

By A. J. MORGAN*
Chief Engineer, Wire-Rope Division,
John A. Roebling's Sons Company

A wide diversity of opinion exists on wire-rope lubrication practice. This the author reviews, then he gives fundamental qualities necessary in a good lubricant to act both as a protector and a lubricant, and outlines methods of applying it

WHEN establishing a lubrication practice for wire ropes it is necessary to first determine the degree of protection necessary to meet existing conditions. Safety of men, materials and production frequently depend upon wire rope, and its reliability in turn depends upon proper lubrication. If a surface inspection of a rope is to be of any value it must be known that its inside wires are intact and that it has not been allowed to corrode.

Out of the many procedures that have been advocated and ideas developed regarding wire-rope construction and use there is agreement that rope should be lubricated, both during manufacture and when in service. Wire rope users in the past have frequently taken the position that the lubricant put into the rope by the manufacturer should be sufficient during its life. They did not believe it necessary to apply lubrication to the rope after it went into service.

Fortunately, this attitude has changed, and good lubrication practices have been developed by many wire-rope users, generally on recommendations of wire-rope companies. These recommendations often resulted in users setting up their own particular practices to meet local conditions. This is a desirable development because intense competition between builders of machines using wire rope has resulted in designs of equipment that are not favorable to economical wire-rope service, although machine operation as a whole may be satisfactory. Therefore, to meet these conditions it is frequently necessary to take advantage of every favorable practice to make wire-rope service economical. Needless to say, proper lubrication is an important feature.

Proper wire-rope lubrication practice varies with the installation. What may be highly satisfactory on one installation might be far from this on another. It does not seem possible at this time to set up a definite recommendation for wire-rope lubrication that will apply under all conditions. In addition to the different installation requirements it is well to bring out another thought in this connection. If a lubrication method is developed by the men responsible for the rope and they believe it to be proper, the rope is likely to be better protected as a result of that practice than if they were required to use a superior lubrication practice with which they did not thoroughly agree. This is a point which may seem trivial, but nevertheless is worthy of serious consideration.

The problem of wire-rope lubrication divides into two general classifications: First, lubrication during manufacture; second, lubrication of the rope in service.

There are a number of points of difference in various practices and opinions on the lubrication of the hemp center. One theory is that the hemp center acts as a reservoir for the lubricant that should be replenished at the regular periods of service. Another school of thought takes the position that the hemp center should be treated with a preservative that will remain in the fibers during the rope's life. There is much to be said in favor of the latter, but many rope engineers have considerable doubt concerning the ability of the hemp center to retain and furnish lubrication for the strands during the life of the rope.

Hemp Center

Examination of wire ropes that have been in service furnishes much valuable and practical data for establishing proper lubricating practices. When wire rope has been sufficiently lubricated in use, its hemp center is never found to be dry, but is well lubricated from the lubricant applied to the outside of the rope. The rope lasts longer because of this lubricant. In other cases where the rope has not been properly lubricated after going into service, the center has been found to be dry with no evidence of lubricant in it, although the lubricant was there originally.

As a side-light on this problem, two ropes were made in one piece, then cut in two and shipped to two different places. As far as could be determined physically, these ropes were identical, having been made in one piece. The piece used in one installation made a record, while that used on the other installation resulted in a complaint for short service. Samples of both of these ropes were examined, and definite proof established that lubrication of one rope in service accounted for its long life and lack of lubrication was responsible for the short life of the other. In the rope that gave good service, the lubrication was good, the hemp center maintaining its elasticity. As may be expected, the other rope was found to be badly corroded and the hemp center deteriorated so that it no longer furnished proper strand support.

Examination of other ropes that have been in service indicates that lubricant can be re-introduced into the hemp center, so that it will be lubricated throughout its life. This is important, as it is evident that a proper lubrication practice should not let the center dry out and the original lubricant be replaced by moisture.

Lubrication of the strands can be accomplished in several ways, either during their fabrication or by applying the lubricant to the strands themselves. Here again a considerable difference of opinion exists as to the proper type of lubricant to use. This may vary from various types and weights of oils to a wide range of types and weights of greases. The duty that the rope is to perform must be taken into account and a lubricant used that gives the required protection and lubrication for most efficient service.

Kind of Lubricant

Wire-rope manufacturers use a lubricant that, in their opinion, is most suitable for the particular service. The lubricant should be of a nature that will not easily run off, even at summer temperatures, nor should it harden sufficiently to crack and strip off during the winter months. It should not be readily washed off and should not be so gummy that it will hold gritty dust and allow it to work into the rope, thus hindering penetration of the lubricant. Further, the lubricant should not be of a nature that will absorb or be disintegrated by water or the usual corrosive liquids encountered in service.

To assist in indicating the importance of the characteristics for suitable wire-rope lubricant, it might be well to quote from the specifications, "Wire Ropes for Mines," listed in Chapter 41 of the Lubrication Engineering Committee Report, as adopted by the Engineering Standards Committee as American Standards Feb. 24, 1927, for which the American Mining Congress was sponsor. This contains, in Section 611, several very good requirements on wire-rope lubrication. Rules 6110 to 6118 read:

"It is advisable that the lubricant recommended by the rope manufacturer be used.

"Wire-rope lubricant should be commercially chemically neutral.

"It should not harden sufficiently to crack, chip, or peel, nor soften sufficiently to drip off the rope under extreme atmospheric conditions.

"It should not dry out rapidly in service.

"It should be practically free from moisture, not absorb moisture readily, and be impervious to surface moisture.

"It should be of such nature that it can penetrate between the strands to the core of the rope, and should be applied in such a manner as to secure the maximum penetration.

*Abstract of a paper, "Lubricating of Wire Rope," presented at the Second National Lubrication Engineering Meeting held at Pennsylvania State College, under the auspices of the College and the Lubrication Engineering Committee of the Petroleum Division, A.S.M.E.

"It should possess such adhesive qualities as not to be thrown from the rope by vibration nor rapid motion.

"Its physical and chemical qualities should permit heating to liquid consistency for ease of application.

"Lubricant should be applied at frequent intervals to protect the wires of the rope from friction and corrosion."

These rules are of a general nature and apply to lubrication of wire-rope during manufacture and while they are in service. A suitable lubricant for use in the field may be somewhat different from that which can most readily be applied while the rope is being fabricated. It is easier to obtain thorough penetration with heavier lubricants during fabrication than it is in the field.

When lubricating a rope in the field, all rope manufacturers agree that the rope should be cleaned and freed from moisture as thoroughly as possible before applying the lubricant. There are a number of ways of doing this. Possibly the easiest and generally most satisfactory way is to use compressed air or a steam jet, or a combination of both. There are also methods employing wire brushes and tools, shaped generally to the contour of the interstices of the strand, which rotate as the rope is passed through them, these tools cleaning the valleys or interstices of the rope. The rope should be as clean and as dry as possible and the valleys between the strands free from caked lubricant. If this is not done, thorough penetration of the lubricant cannot be obtained.

The type of lubricant necessary and its application depends on the character of the service and the particular practice employed. The lubricant may be applied by running the rope through a trough or through a box, or brushed or swabbed on the rope. There is also the drip system, used extensively, consisting of dripping the lubricant (necessarily relatively light quality) onto the rope, ordinarily at the time the rope is bent over a sheave. It is difficult to lay down definite rules for doing the lubricating that will apply in all cases. Local and climatic conditions must be taken into account when choosing the lubricant.

It might be well to consider the possibility of splitting the application in two parts, the first part of which would be to produce thorough penetration, using a relatively light lubricant, and the second part to give protection to the outside of the rope, together with a small amount of penetration. Ropes treated in this manner have been observed to be effectively protected and lubricated, but the practice must be adapted to the particular conditions present and no definite rules have yet been devised.

It is an established fact that ropes can be maintained in a lubricated condition by any of the methods briefly touched on, providing the applications are sufficiently close together and thorough.

By-Product Power Practice Abroad

By CARL ZUBLIN
Berlin, Germany

IN RECENT years there has been a trend towards rationalizing works using heating steam and power and extending them, thus endeavoring, as far as possible, to make up for past oversights. This article will outline several interesting installations using reciprocating engines.

In the Albbruck paper mills, a Sulzer primary steam engine was recently put into service. This is a 500-b.hp., 250-r.p.m. machine operating at 500-lb. throttle pressure. Before the latest extension, the plant consisted of a 400-kw. hydraulic turbine, with much energy purchased. The paper machines were driven partly by water power and partly by individual steam engines. The latter worked with throttle steam at 115 lb. and 480 deg. F. Back pressure varied from 10 to 15 lb.

To extend this plant, a primary high-pressure steam engine was installed. A new boiler supplies steam at 500 lb. and 700-750 deg. F. Two cylinders, exhausting at 140 lb. and 28 lb., drive a common shaft carrying a three-phase generator. The back-pressure steam at 140 lb. is led to the old steam engine, while the steam at 28 lb. goes to the heating apparatus. A heat accumulator is connected to the 140-lb. system.

An example of a plant in a chemical works is the one built for Messrs. Blattmann & Co., manufacturers of starch, dextrin and chemicals at Wädenswil, Switzerland. The plant installed consists of two Sulzer single-bank upright water-tube, 215-lb.-pressure boilers with superheaters, economizers, underfeed stokers and a Sulzer back-pressure steam engine rated at 250 b.hp. The engine operates at 250 r.p.m. with 200-lb., 570-deg. throttle steam and a back pressure of 30 lb. It drives a flywheel generator mounted on the shaft.

Control is by a speed governor working in conjunction with an oil-operated regulator. This keeps the heating pressure constant at 30 lb. If the exhaust steam from the engine is not sufficient to cover the demand, the difference is made up by supplying live steam through a pressure-reducing valve.

Strictly speaking, the steam engine in the Wädenswil plant does not work in conjunction with the heating services, since it is under the influence of a speed governor and is not operated according to the demand for heating steam. A steam engine working solely according to the demand for heating steam has no actual speed governor, but is controlled by the steam-pressure regulator in such a way that all the steam required for manufacturing purposes or heating passes through the engine.

This method of operation requires a second source of power, either a second engine, a steam or diesel engine, or a utility connection. The back-pressure steam engine is coupled to the second source of power—preferably electrically—and thereby kept in step.

Another method of achieving the same result adjusts the speed of the engine according to the demand for exhaust steam. An example is the new steam power station of the Robertsau Paper Mills at Strassburg, comprising two Sulzer back-pressure steam engines, one of which is remote-regulated in accordance with the back pressure. This engine develops normally 210 b.hp. at 250 r.p.m., with 170-lb. throttle pressure and a back pressure of 35 lb.

The second engine in the same station has a simple speed governor. It develops normally 400 b.hp. at 214 r.p.m. with steam at the same initial pressure and with a back pressure of 15 lb. The back pressure of 15 lb. is kept constant by a pressure regulator which delivers steam from the 35-lb. system to the 15-lb. system as required. These engines work in parallel with purchased current and also with a hydraulic turbine plant.

To remove oil from steam-engine exhaust, separators are available which clean the steam until only a trace of oil is left—at the most about 0.1 ounce per ton. This proportion is so small that it is no drawback in most processes.

When the least trace of oil might have a bad effect (such cases are very rare) complete oil removal may be obtained with a chemical purifier. The steam is led through nozzles into a large tank about two-thirds filled with water containing aluminum sulphate and caustic soda. The purified steam issues at the top. In passing through the water, the last traces of oil are chemically combined with aluminum hydroxide and precipitated to the bottom of the tank as a sediment, which has to be removed from time to time. This is a simple and inexpensive apparatus for which, as a rule, the shell of an old boiler may be used. Operation is simple and the cost of the chemicals, which have to be added at intervals of three to four weeks, is insignificant.

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Managers
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ERNEST L. OHLE,
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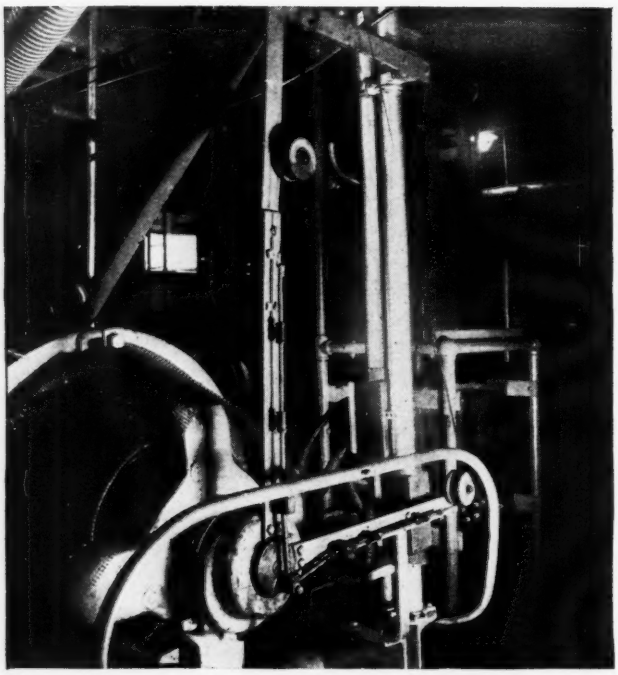
Washington University
JAMES A. HALL,
Professor Mech. Engrg.
Brown University

PRACTICAL AIDS TO OPERATION



Two-way Crank Simplifies Taking of Vertical Indicator Cards

On a Winton diesel engine in the Columbia University mechanical laboratory, a special device is mounted to simplify the taking of both the normal and the so-called "vertical" indicator cards, which emphasize the combustion portion of the cycle. Since one crank and connecting rod parallels those of the cylinders, it gives a true diagram; the other distorts the combustion portion. Built up of strap-iron bolted to the endbell of the generator, the frame of the device carries suitable pulleys for the steel tapes leading to the indicator. The connecting rods lead from the same crank, one vertically and the other horizontally, converting their rotary motion to reciprocating through conventional crossheads. The steel tapes or ribbons leading to the indicator insure greater accuracy due to elimination of stretch and whip encountered with cord. Since both tapes are held taut by springs over pulleys at their opposite ends, it is a simple matter to take the cards in rapid succession, thus avoiding the usual labor of relocating the tape and the danger of changed conditions between cards.

Rotor Unbalance Caused Flat Spots on Slip Rings

In one of our alternators, flat spots were continually developing. Regrinding only provided a temporary solution. The cause was finally traced to unbalance. Grinding was done while the generator was at full speed, and it was clear that the surface of the ring was not following a truly circular path, with the result that the brushes vibrated when the machine was in operation. This would cause the flat spots.

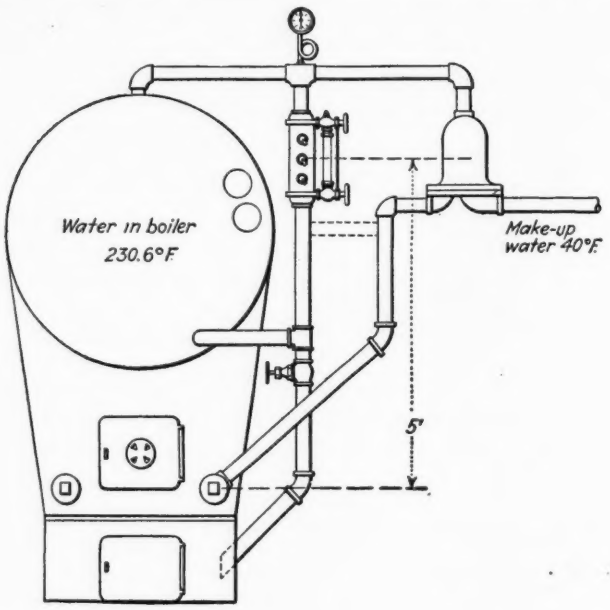
To remedy the trouble, the rotor was rebalanced and then the rings reground. During regrinding it was noticed that more metal was removed from some parts of the ring than others, showing that the previous surface was not true.

When polishing was completed, the brushes were replaced and the generator put into service. There was no further trouble with flat spots, showing that unbalance was the cause of the trouble. When conditioning the rings, it is always advisable to do final grinding at the working speed. This will give a ring surface true at that speed, and remedy any slight error due to distortion which might otherwise occur. W. E. Warner

Herts, England.

Difference in Water Temperature Caused Feed-Water Regulator Trouble

It was found advisable to install a feed-water regulator on a heating boiler to make up for condensate lost from radiators deemed uneconomical to return to the boiler.



The regulator, a small float-actuated type, after the installation apparently failed to work. Each time it was put into service, it filled the boiler to a level that caused water to be carried over into the steam lines.

The service engineer of the company supplying the regulator was called in, but could find no fault with the installation. He claimed the regulator was defective and had a new one installed. Before installing the second regulator it occurred to me that the difference in density of the two water columns which were at different temperatures might cause the trouble. The water in the boiler has a temperature of about 230 deg. and in the column from the bottom of the boiler to the regulator a temperature of about 40 deg. F.

The pressure at the base of a column of water one foot high at 40 deg. F. is 0.4334 lb. per sq. in., and at 230 deg. F. it is 0.4123 lb. per sq. in. At the base of a

5-ft. column the pressure is therefore 5x0.4334= 2.167 lb. per sq. in. at a temperature of 40 deg. F. This is equivalent to a column of water 2.167÷0.4123= 5.256 ft. high at 230 deg. F. Therefore a column of 40-deg. water 5 ft. high will balance a column 5 ft. 3 in. high at 230 deg.

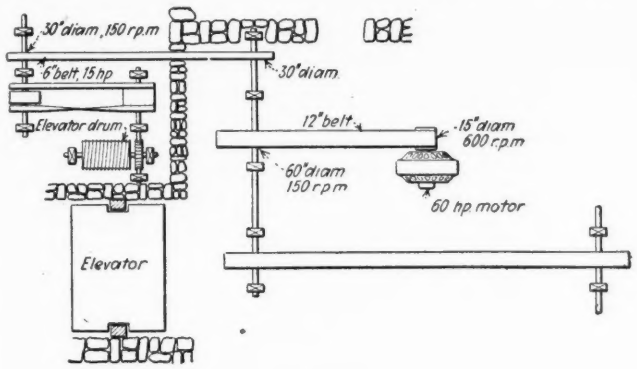
Our remedy for the trouble was to lower the regulator, setting the level mark on its body in line with the bottom of the gage glass. Another way would be to connect the feed line into the water column as shown in dotted lines.

Camden, N. J. MILTON W. SHAFFER.

Increased the Belt Speed to Increase Its Power

IN A MILL, the elevator was driven from a line shaft in turn driven by a 6-in. belt from a second line shaft, as in the diagram. Load was added to the line shaft driving the elevator until the total load was about 35 hp. This raised the problem of how to transmit the increased power to the shaft.

The 6-in. belt operated on 30-in. pulleys and was good



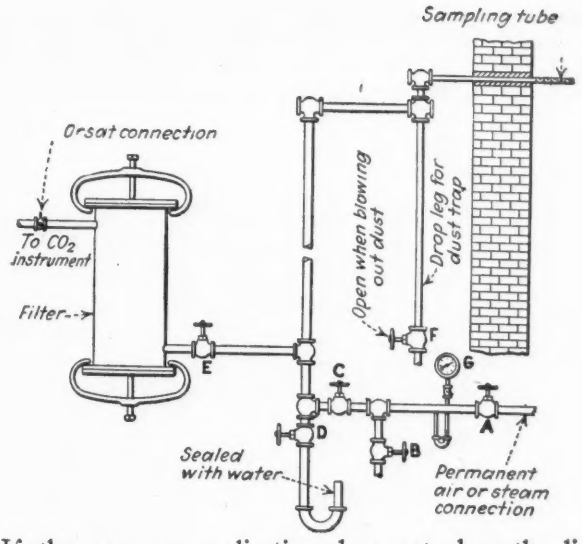
for about 15 hp. As the belt's width could not be increased conveniently, it was decided to increase its speed. On the 30-in. pulleys, belt speed was about 1,200 ft. per min. By replacing the 30-in. pulleys with others 64 in. in diameter, belt speed was increased to 2,500 ft. per min. This made it good for 35 hp. C. W. PETERS

Boston, Mass.

Proper Piping Arrangement Insures Easy Cleaning of CO_2 Lines

WHEN installing CO_2 indicating or recording instruments, provisions should be made to keep the piping and fittings clean. In some plants with the piping system laid out as shown in the diagram, in the event of a connection plugging up, and also once a week, the following procedure is practiced:

Valves *B, D* and *E* are closed, and valves *A, C* and *F* are opened. After steam or air, whichever is used, blows through valve *F,* showing that the drop leg is clear, this valve is closed. Pressure is maintained on the line for a minute or so longer to clean the sampling tube. Indication that this tube and the rest of the piping is clear may be had by closing valve *C* for a moment, then opening it and at the same time observing pressure gage *G.* If the line is clear, as soon as valve C is reopened a noticeable reduction in pressure will show as flow is established. If the line is still stopped the pressure shown by the gage will remain almost constant.



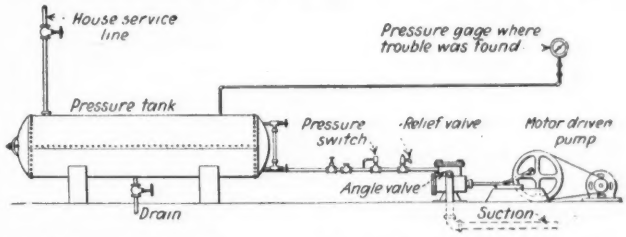
If the pressure application does not clear the line, removal of the plugs in the various tees and crosses and the use of a long piece of hooked piano wire will readily clear the obstruction.

Valve *B* is left open during normal operation. In case of a leak through *A,* an indication of this is given by the escape of air or steam. This valve being open also prevents any possible air or steam leaks through valve *C* into the instrument. C. A. ARMSTRONG

Cleveland, O.

Hole in Bourdon Tube Causes Trouble on Water System

THE boiler plant of a hotel secured its water supply from the local waterworks. Static pressure at the entrance to the building averaged only 25 lb. per sq.in. It was desired to maintain a pressure of at least 60 lb. to insure satisfactory service. A pump and pressure tank were installed, as in the diagram. A pressure switch stopped the pump at 70-lb. pressure and started it again



at 55 lb., pressure being maintained over this range by air in the upper part of the tank.

This system gave good service for a long time, and then it was noticed that the pump operated more often than normal. The tank would become water-logged in a short time after charging with air, this giving indication of an air leak. A candle flame was passed over all riveted joints, pipe joints, etc., and a soap solution was painted on, but the leak was not discovered.

Later one of the engineers was polishing the gages on the panel board and when he came to the water-pressure gage he noticed a slight hissing noise. Having in mind the trouble with the water system, he removed the gage and found a slight break in the soldered seam of the Bourdon tube in the gage through which the air was leaking. C. R. JONES

Philadelphia, Pa.

CURRENT COMMENT

Buying Coal

IN *Power* for May, "Buying Coal Looks Easy" covers the subject ably, except one point. This is of vital importance to the owners—the comparative costs of steam, in dollars and cents, for various coals.

Having burned about everything from hand-picked anthracite to duff, I have met with some surprises. Locally we draw on the Illinois fields almost entirely for boiler fuel, and the grade of coal that is most available, nearest and cheapest, is by no means of the best quality. With about 35 to 40 per cent volatile matter and fixed carbon, and 20 to 25 per cent moisture and ash, yet with approximately the same analysis, there is a variation in the cost of steam.

Many years ago, I was in a plant where the load was approximately uniform for eight months out of the year, and we kept a check on our monthly consumption. We found that coal from one particular mine gave more steam per dollar than any of its neighbors, yet repeated analyses showed no great difference. At the time of the great tornado of 1896, coal shipments were delayed a few days by damage to the bridge, so we purchased Pittsburgh coal from the local gas company. To our surprise, while coal consumption was less, it was not much less.

Local opinion can be at fault too; at a mill in Arkansas we burned screenings from Alabama, Pittsburgh, Kansas, and Carterville, Ill., at almost the same cost laid down. Based on evaporation, taking the Alabama as 100 per cent, the Pittsburgh screenings showed an efficiency of 98 per cent and the Carterville, 92 per cent. Left to a vote of the firemen, Carterville came first, the reason being that it made less ash; higher moisture and oxygen contents were not visible.

In the coals whose analyses are given, I fail to see why there should be such a difference in relative efficiency if fired under the same boilers and under the same conditions, as samples from the same car may vary as widely as this. I say "same conditions," because two coals, giving the same results under normal load, may vary widely when the boilers are forced. In this case the one with the lower volatile gives the higher rate of evaporation, which is characteristic of the Cambria Co. (Pa.) coals which these resemble.

L. R. BAKER

St. Louis, Mo.

Most Economical Size for Power Conductors

WHEN reading in the June number on page 320 the answers to the question on, "Size of Conductor for Three-Phase Motor Load," I was surprised to find that the authors gave no consideration to the most economical size of conductors to use on the job. One might easily draw the conclusion from the answers that there are a lot of uneconomical distribution lines installed. Because a conductor meets the requirements of current-carrying capacity and voltage drop is no reason to believe that it is the most economical to use. In the following, the conductors for the load have been selected on the basis of factors that will give the lowest annual cost. Of course, these factors will vary with conditions, but the method of applying them to the problem will hold for any installation.

It is stated in the question that the motors may not all be fully loaded at the same time, and even though they were, it is more than likely that the power factor will not exceed 90 per cent lagging. Anyway, it will be safe to consider 90 per cent power factor for the purpose of design.

$$\text{The kilowatts, } Kw. = Hp. \times 0.746 = 870 \times 0.746 = 649$$

$$\text{The current } I = \frac{649{,}000}{2{,}300 \times 1.732 \times 0.9} = 181 \text{ amp.}$$

This may be considered as the maximum current, but to determine the most economical-size conductor, it will be necessary to know the mean annual current. I_a, the mean annual current, may be defined as the current in amperes, which must be substituted in the Kelvin-law equation, to give the most economical-size conductor.

$$I_a = \sqrt{(I^2_1 \times T_1) + (I^2_2 \times T_2) + (I^2_3 \times T_3) + \ldots}$$

Where I_1 equals the current in amperes carried T_1 per cent of the time; I_2 equals the current carried for T_2 per cent of the time, etc.

As an example, assume that 181 amp. is carried 25 per cent of the time; 75 per cent of 181 = 136 amp. carried $\frac{1}{3}$ of the time; 50 per cent of 181 = 90.5 amp. carried $\frac{1}{4}$ of the time; and $\frac{1}{3}$ of 181 = 60 amp. carried $\frac{1}{6}$ of the time. From which

$$I_a = \sqrt{(181^2 \times 0.25) + (136^2 \times 0.333) + (90.5^2 \times 0.25) + (60^2 \times 0.167)} = 130 \text{ amp.,}$$

This means annual current (130 amp.) will be used in the following calculations, which will also be predicated on 2,240-hr. operation per year.

In the design of circuits with heavy conductors, the cross-arm loading is usually the limiting factor. That is, the span length is governed by the cross-arm loading.

For a 500,000-circ.-mil copper cable, loaded with $\frac{1}{2}$ in. of ice, with the three conductors on a standard $3\frac{3}{4}$-in. x $4\frac{3}{4}$-in., 4-pin arm, using the two end pins and one pole pin, the fiber stress in the arm will be about 1,200 lb. per sq.in., which is about the allowable maximum working load. On this basis, the approximate span lengths are as follows:

Circ.-Mill Cross-section	Span Length, Feet	Circ.-Mill Cross-section	Span Length Feet
500	95	300	135
450	100	250	155
400	110	Wire Size	
350	125	0000	175

The sizes of conductor given in the table are those that come in the range of consideration.

The cost of a 35-ft. creosoted pine pole, at present-day prices including a single cross-arm with pins and insulators, and including all overhead costs, installed under ordinary conditions, is approximately $20. The present-day price of copper is about 10c. per lb. delivered. The cost of stringing the wire, regardless of size, is about 5c. per lb. This makes the installed cost 15c. per lb. On this basis, we have the following conditions:

Wire Size	0000	250,000 Circ. Mils	300,000 Circ. Mils	350,000 Circ. Mils	400,000 Circ. Mils	450,000 Circ. Mils	500,000 Circ. Mils
Span length, feet	175	155	135	125	110	110	95
Poles required	7	8	9	10	11	12	13
Weight of wire, lb.	2,351	2,779	3,334	3,888	4,464	5,004	5,544
Cost of poles inst.	$140	$160	$180	$200	$220	$240	$260
Cost of wire inst.	353	417	500	583	670	750	832
Total first cost	$493	$577	$680	$783	$890	$990	$1,092
Annual I^2R losses, kw.-hr.	7,165	6,076	5,074	4,361	3,830	3,417	3,089
Cost I^2R loss at $0.015	$107	$91	$76	$65	$57	$51	$46
Fixed charges at 11%	54	63	75	86	98	109	120
Total annual cost	$161	$154	$151	$151	$155	$160	$172

It will be seen from this that the conductor showing the lowest cost is either 300,000 or 350,000 cir.-mils. which are exactly the same. The size to use will depend on whether any appreciable increase in the load is to be expected. If the load is not to increase, then the 300,000-circ.-mil size should be used. This size wire has more than double the cross-sectional area of the largest wire suggested in the answers to the question in the June number.

I have worked out the problem to include a size as small as No. 0. It is not considered good design for this class of construction to go to span lengths in excess of about 200 ft. The annual cost, using No. 0 copper, and a 200-ft. span, is:

Cost of poles installed	$120
Cost of wire installed	176
Total cost	$296
I^2R losses, kw.-hr.	14,320
Fixed charges at 11%	$33
Cost I^2R loss at $0.015	214
Total annual cost	$247

From this it will be seen that the increase in annual cost due to use of a No. 0 instead of a 300,000 circ.-mil conductor is $247 - 151 = \$96$.

There is a spread of only $21 per year between a 300,000- and a 500,000-circ.-mil conductor, and $10 per year between a 300,000-circ.-mil and No. 0000 conductor. Therefore, it is a matter of judgment of the man responsible for the design as to which size to use. On the other hand, there is a spread of $96 between a 300,000-circ. mil and a No. 0 conductor, which at 11 per cent will justify an expenditure of $873.

There are several factors, any one of which may materially change the final result. These are energy cost, fixed charges, hours of operation and installation cost. The designer should know the energy cost, the fixed charges and the hours of operation, and should be able to estimate the installation costs very closely. He can substitute the known values in the table of costs, from which the final result will indicate what size conductor to use.

Raleigh, N. C. F. C. DeWeese

Work Bench Made of Welded Pipe

R. L. Wagner describes how a work bench was made of welded pipe in the May number, page 271. It occurs to me that a great deal of skilled labor was required to make a rather simple piece of equipment. The bench could have been made in much less time by using small angles for the four legs and top frame and flat iron or angles for the end cross-bracing. As for the sides, angle knee braces slanted at an angle of 45 deg. and placed about 18 in. from each end would have been more appropriate than the bracing used. A steel plate top reinforced crossways with light angles could have served for the top as well if not better than an iron casting. Depending on equipment on hand, such a bench could be either riveted, bolted, or all welded.

Pittsburgh, Pa. Benard Kramer.

Continuous Supply of Cooling Water Delivered to Bearing

The principal objection to Frank W. Bentley's method for keeping a bearing cool (*Power,* May, page 270) is that the water is likely to become exhausted in a short time. A method that I have used successfully for cooling bearings, is a canvas belt placed on shaft close to the bearing and is allowed to hang into a pail of cold water. As the shaft rotates it causes the belt to move around on the shaft and carries water up on to it. Any flexible belt that absorbs water readily will serve the purpose. With this method, there is no splashing of water and it does not get into the lubricant.

Atlantic Highlands, N. J. M. M. Gooch

The Problem of Fire Control

The problem of fire control is of vital importance to the engineering organization of every industrial plant. I have found that in most plants this organization is directly responsible for the condition and use of the fire-fighting equipment. All fires, with the exception of explosions, are small when they start; if equipment is readily at hand for their control they can be held in check and in most cases extinguished before the fire department arrives.

Some years ago I was engineer in a large woodworking plant in which the responsibility for fire prevention and control was centered in my department. A woodworking plant is generally considered a serious fire hazard, but if proper protection is provided this danger can be greatly minimized. I organized fire brigades in each department, the foreman being responsible for a group of four men trained to handle a fire hose and portable fire extinguisher. These men were held responsible for the condition of the fire equipment in their charge. It was their job to see that this equipment was at all times in good repair and ready for immediate use. Two men were detailed in each department to go to the nearest fire alarm box and call the city fire department if only a suspicion of fire existed.

All stairs and passageways should be kept free of obstructions of any kind, so that employees and firemen may move about freely without danger of tripping or being injured. A few seconds delay in handling a fire may lead to a catastrophe. See that all fire hydrants in the vicinity of the plant are kept free of obstructions and in condition to be operated at all times.

If the plant has a sprinkler system, detail a man to go to the valve on it to make sure that this valve is not closed by some unauthorized person when the water is needed on a fire. Never allow anyone to close the sprinkler valve when the alarm sounds until the cause for the alarm has been found. Closing the sprinkler-system valve has caused some costly fires. Finally, don't expect too much of the watchman, and be sure that he is properly instructed in how to turn in a fire alarm.

Flint, Mich. G. W. Jacobs

READERS' PROBLEMS

Copper Gaskets

COPPER GASKETS AT HIGH TEMPERATURE—*We are considering the use of copper gaskets for pipe joints for steam lines of 400 lb. pressure and 750 deg. temperature, but have been told that copper disintegrates at this temperature. Is this true?*—C.G.H.

Copper gaskets have been used in smaller-sized joints for steam conditions of 650-lb. pressure and 730 deg. temperature with satisfactory results as compared with other materials on the market for this service. The copper did, however, disintegrate to a certain extent under these conditions, but as a rule the efficiency of the joint was not affected.

Under the steam conditions given in your question, there will be considerable disintegration of the copper after two years of service.

Furnace for Oil Burning

Answers to June Question 1

THE QUESTION

WE HAVE two 8,000-sq. ft., sectional-header boilers in our plant. They are fired by underfeed stokers. The furnace volume is about 1,600 cu. ft. and can obtain a maximum rating of about 200 per cent. We are considering changing over to oil burners and want to know what changes should be made to the setting. Should the stoker be removed, and can we expect to obtain increased output with oil fuel?

W.MCW.

Cover Stoker With Fire Brick

TO OBTAIN the size of combustion space required when changing from coal to oil firing, it is necessary to ascertain the approximate heat release in B.t.u. per hr. per cu. ft. of combustion space to give satisfactory operation.

Average Range of Heat Release for Various Types of Firing

Type of Firing	B.t.u. release per cu.ft. Combustion space per hour
Stokers (Chain Grate)	30,000 to 40,000
Stokers (Underfeed)	30,000 to 45,000
Fuel Oil	35,000 to 40,000
Pulverized Fuel	15,000 to 45,000

From the data given we arrive at the approximate heat release per hour per cubic feet of combustion space, as follows:

8,000x3=24,000 lb. steam per hour at rating and 24,000x2=48,000 lb. steam per hour at 200 per cent rating.

Assuming each pound of steam contains approximately 1,000 B.t.u. then 48,000x 1,000=48,000,000 B.t.u. output per hour per boiler.

Further assuming the boiler efficiency to be about 70 per cent then

$$\frac{48{,}000{,}000}{.7} = 68{,}600{,}000 \text{ B.t.u. input per hour to the boiler.}$$

With the furnace volume given as 1,600 cu. ft., we obtain

$$\frac{68{,}600{,}000}{1{,}600} = 43{,}000 \text{ B.t.u. per hr. per cu. ft. combustion space (approx.)}$$

This release exceeds the upper limit suggested for satisfactory operation with oil. Assuming the furnace to be solid refractory, removal of the stokers to provide more volume would be recommended. However, if the setting is high it might be possible to leave the stokers in place and protect them with a course of fire brick.

It is difficult to give exact rules to be followed in the design of combustion chambers. The following information is given to indicate the more important points to consider.

1. The chamber should be designed to get the maximum flame distribution, taking into consideration the size and shape of the flame.

2. Provide the maximum flame travel, taking into consideration the location of flue passages through the heating surface.

3. All the direct heating surface of the furnaces should, if possible, be exposed to the radiant heat of the flame and should not be covered with refractory material unless it is necessary to prevent direct flame impingement.

4. To obtain uniform flame distribution, square corners should be avoided and the surfaces of the combustion chamber should curve upward to increase turbulence without creating downward eddy currents from the flame.

5. The center line of the burner should be kept up from the hearth to prevent flame impingement thereon, and also to permit free air below the flame to combine with it and complete combustion and prevent and coke deposits on the hearth.

A medium-sized, oil-fired furnace should average 3 to 5 per cent higher efficiency than a corresponding coal-fired furnace. Efficiencies of 75 per cent are common when skill and the use of recording instruments such as oil meters, steam flow meters, CO_2 recorders and draft gages are used to guide the operator.

New York, N. Y. R. S. JULSRUD.

Furnace Too Small

FIRST, I believe 1,600 cu. ft. furnace volume is much too small for oil-burning under boilers of this size.

The writer is operating four 5,000-sq. ft. boilers which have approx. 0.5 cu. ft. of furnace volume for each square foot of boiler surface. Using the same ratio, an 8,000-sq. ft. boiler should have about 4,000 cu. ft. furnace volume.

I would certainly remove the stokers if a careful analysis of the facts showed that a change to oil will be a paying investment. It has been the writer's experience that oil burning with stokers in place and "bricked over" is unsatisfactory both as regards boiler operation and furnace maintenance.

The writer recalls a statement made by an authority on combustion that three things were essential in a boiler furnace if satisfactory combustion conditions were to be secured, namely: temperature, turbulence and time. Temperature sufficient to ignite the fuel as soon as it enters the furnace. Turbulence to get an intimate mixture of fuel and oxygen as quickly as possible and a sufficient distance between point of fuel entrance and tube surface to insure complete combustion of fuel and combustible gas before the tube surface is reached.

The first condition implies either furnace walls at high temperature or rapid combustion of comparatively large volume of fuel continuously. The second condition, with oil or pulverized fuel burning, is dependent on burner design, burner location and method of supplying air. The third condition is dependent upon furnace length or height or a combination of the two.

With a properly designed furnace, an increased output may reasonably be expected.

Our boilers are fired under the "low end," and two lower rows of tubes are exposed to radiant heat for their full length, a flat baffle being placed on the second row of tubes and extending about 40 per cent of the tube length. A vertical baffle starts at this point and slopes backward to a point on upper row of tubes about ⅓ tube length from rear header. The second baffle is placed about half way between first baffle and front header.

This method of firing and baffling allows gases to travel horizontally nearly the full tube length, upward through first pass, downward through second pass, upward through third pass and out of stack at same end of boiler as fired.

Increased boiler efficiency may be expected with oil over coal due to better air control, resulting in a higher CO_2 and a lower exit temperature of flue gas.

The rating at which the boilers can be run will depend upon the available draft and size of air openings in burner registers. A deficiency of air will cause burners to "flutter" at high ratings.

If forced draft is available, it can be used for supplying air to burners, leaving to the chimney the single duty of removing the products of combustion.

No. Plymouth, Mass. C. B. HUDSON.

No Change Necessary

A FURNACE that is designed to burn bulk coal is also adequate to burn oil, gas, or pulverized coal. Even when the original design is for a chain-grate stoker, it is not necessary to remove the arch, which is not necessary to oil firing. Aside from the fact that it takes so much space, it does no real harm. In this case, since the furnace is underfeed stokered and therefore has no arch, it should be very well suited to oil firing.

Nor is it necessary to remove the stoker, although if this can be done conveniently, it will add to the furnace volume. But

unless the change is to be permanent and it has been definitely decided to dispose of the stoker for good, it is better to leave it as it is. In this way it will be safer and out of the way, and can be again placed into service on short notice should a development in the fuel market warrant such a change.

All that is necessary to protect the stoker from the heat is to spread a layer of ash and then a row of refactory bricks on top.

As to whether the capacity can be increased with oil, calculations show that with the present rate of driving and furnace volume the heat generated is 40,000 B.t.u. per cu. ft. per hr. This is rather high, and too much of an increase in rating should not be attempted, but about 20 per cent is feasible, as there are installations operating at 50,000 and 60,000 B.t.u. per cu. ft. per hr. Of course, if the stokers are removed that will add to the furnace volume and will increase the capacity to the same extent.

Chicago, Ill. N. T. Pef.

Stoker Should Be Removed

It will not be necessary for W. McW. to change the boiler settings for oil burning. If there is no probability of changing back to coal firing the stokers should be removed to (1) give more furnace volume, (2) facilitate adjustment of air supply, (3) and to save expense of covering grates with fire brick.

In this type of boiler it is sometimes advantageous to set the burners at the back of the furnace, introducing the primary air directly below the burners and the secondary air at the front of the furnace. This arrangement allows for expansion of the gases as combustion progresses, and places the burners in a position such that combustion is complete before the flame impinges on the cold boiler tubes.

If the boilers are equipped with forced and induced draft, their output can be increased. If not, increased output will probably be at the expense of efficiency. As a general rule, about 3 cu. ft. of furnace volume for each gallon of oil burned per hour are required.

The most important point is to set the burners as far as possible from the boiler tubes. This will help the efficiency and also check carbon accumulation on the tubes.

Albuquerque, N. M. Ralph J. Rainey

Two Questions for Our Readers

Question 1

Should a 220- and 440-volt, 3-phase, motor-power circuit be ground? We have had considerable discussion on this question in our organization and have not been able to come to a definite decision. Probably some Power *readers will give me the benefit of their experience and opinion.*—C.R.

Question 2

We have a 2,000-g.p.m., single-stage, centrifugal pump operating with a suction lift of about 20 ft. and against a discharge head of about 115 ft. Sometimes this pump will lose its prime when in operation. What might be the cause of this trouble and how may it be remedied?—R.E.S.

Suitable answers from readers will be paid for if space is available for their publication.

Cooling Condensing Water with Refrigeration

Answers to June Question 2

THE QUESTION

WE OPERATE a 120-ton refrigerating system using CO_2 as the refrigerant. During the summer the available condensing water averages about 80 deg. F., resulting in high head pressure and a corresponding increase in power required to operate the compressors for the same refrigerating effect. It has been suggested that some of our refrigerating capacity be used to cool the condenser circulating water and so reduce the head pressure. Would such a scheme secure any saving in power required per ton of useful refrigeration?—L.R.M.

Power Consumption Increased

Nothing can be gained by cooling the circulating water in the refrigerating system. In fact the final result will be a loss. For example, if the circulating water temperature is lowered from 80 to 70 deg. the decrease in power due to lower head pressure will be 15 to 20 per cent, but more than twice as much power will be needed to produce the additional refrigeration.

It may, however, be possible to reduce the power consumption in other ways. In many plants faulty conditions prevail, which when corrected, result in reduction of the power consumption. Some that might be mentioned are:

1. The greater the amount of the circulating water the higher the efficiency, and while in some instances the gain in efficiency may be offset by the cost of water, full advantage should be taken of this point.

2. The suction pressure should be as high as the circumstances will permit. Best results are maintained when the suction pressure is regulated to give a temperature that is 15 to 20 deg. below the temperature of the cooling medium. This faulty condition is encountered in many refrigerating systems and is responsible for a considerable loss.

3. The condenser should be clean. It should be blown daily to remove any uncondensible gases.

The following items pertain to ice making.

4. Appreciable reduction in costs can be effected if the ice water is precooled in a separate tank. The suction pressure here is to be maintained to give a temperature 15 to 20 deg. below the temperature of the water.

5. The temperature of the brine tank should be 15 to 20 deg.

6. The agitating air should be a minimum and should be precooled.

7. The level of the brine in the tank should be as high as permissible.

8. The ice cans should be filled to mark, not an inch or so below.

9. The ice should be harvested regularly and frozen cans not allowed to remain in the brine.

Chicago, Ill. N. T. Pef.

Power Requirements Not Decreased

There will be neither gain nor loss in the method he describes, as it is comparable to taking a dollar out of one pocket and putting it into another. The net efficiency of any refrigerating system is the number of heat units extracted from the refrigerant and imparted to the cooling water, so that the initial and terminal temperatures and the amount of water used, are a direct measure of the refrigeration obtainable.

A better way, if practicable, is to pass the water through a cooling tower. Where the installation is small, a vertical pipe or box through which the water may trickle down, while a fan sends an upward current of air against it, will cool the water appreciably, unless the climate is one of high humidity. Here we have both extremes at times, so cooling towers vary greatly in efficiency accordingly to atmospheric conditions.

High terminal pressures are natural to a CO_2 system, and I do not believe that a few degrees drop in temperature of the cooling water is going to make much difference, if the quantity of water is not limited. Engineers who have had experience with CO_2 machines in marine service say that there is little loss in practical efficiency in tropical waters; if the CO_2 is not condensed to a liquid in a condenser, a large part of it is condensed as soon as an expansion valve is opened; as the gas passes the valve, the sudden expansion of some of it condenses the balance. My practical experience has ever enabled me to check this, but in our early experience with air tools, freezing of the exhaust was a frequent occurrence.

St. Louis, Mo. L. R. Baker.

Decrease Useful Refrigerating Capacity

Cooling the condenser water with part of your available refrigeration would reduce the head pressure and decrease the compressor horse-power per ton of gross refrigeration. But this manner of operation would be false economy.

If your actual load is 120 tons, you will then increase this tonnage by the amount of work that is done in cooling the condenser water below 80 deg. The additional kilowatts consumed by adding this extra load to your compressor will amount to more than the saving incurred by operating with a lower head pressure, due to cooling your condenser water. There would be a slight gain in compressor capacity, due to the lower head pressure, but this gain would be lost in the additional load which would increase the head pressure.

Glenolden, Pa. D. S. Bousum.

THE ENGINEERS BOOKSHELF

Humidity Measurement

HANDBOOK OF INDUSTRIAL TEMPERATURE AND HUMIDITY MEASUREMENT AND CONTROL, *By M. F. Behar. Published by Instruments Publishing Co., Pittsburgh, Pa. Cloth; 6x9 in.; 420 pages, illustrated. Price $4.*

This volume contains parts II and III of the Manual of Instrumentation in which the author has undertaken the task of interpreting the trends and recording the state of the science of instrumentation as it is developing today in the United States. The first volume, Fundamentals of Instrumentation, together with this one, has been appearing serially in the magazine *Instruments*. Parts of the manual to be published later include the measurement and control of pressure, time and speed, flow, electricity and miscellaneous group concerning liquid level, vibration, accoustics, radiant energy, simple magnitudes and quantities.

The subject of temperature measurement and control is covered in seven chapters: Temperature—General, Indicating, Thermometers, Thermoelectric Pyrometers, Radiation and Optical Pyrometers, Temperature Recorders, Automatic Temperature Control, Temperature-Control Instruments and Accessories. Part III on humidity measurement and control contains four chapters. These are, Humidity—General, Humidity Measurement, Humidity and Aerological Measuring Instruments, Automatic Control of Humidity.

Tables and Formulas

HANDBOOK OF MATHEMATICAL TABLES AND FORMULAS (1933). *By Dr. Richard S. Burington, Case School of Applied Science. Published by Handbook Publishers, Inc., Sandusky, Ohio. 264 pages, 5¼x7¾ in. 57 figures. Flexible fabrikoid covers. Price $2.*

Statisticians, engineers, estimators and consultants will welcome this work, combining essential formulas and tables in one convenient volume. Well indexed, carefully printed and conveniently bound, it shows attention to the needs of a table-user that is uncommon. It is in two parts, the first containing formulas and theorems from elementary mathematics, and the second going into logarithms, constants, trigonometric functions, powers, roots, reciprocals, primes, gamma functions, interest, discounts, annuities, probability integral, elliptic integral, etc.

Steam Power

ELEMENTARY STEAM POWER ENGINEERING. (SECOND EDITION). *By Edgar MacNaughton. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Cloth. 649 pages, 6x9 in. Illustrated. Price, $5.*

This is a second edition of a well-known text on steam-power engineering. The presentation followed is the same as in the previous work. Some chapters have been enlarged, obsolete material removed and new material, illustrations and problems added.

Major additions are, use of Keenan steam tables, a discussion of intrinsic energy, work done under the expansion used in steam-power apparatus, theoretical steam-power cycles, boiler performance, furnace refractories, automatic combustion control, handling of ashes from pulverized coal furnaces, heat balancing, trends in boiler rating, fan performance, pump performance, modern power-plant trends, power plant location and costs, power plant buildings, and the mercury-vapor steam cycle. Descriptions of desuperheaters, purifiers, reheaters, pulverized coal preparation and burning systems, oil and gas-burning systems, motor control valves, welded piping, feedwater heaters, purifiers, evaporators, high-pressure and multi-cylinder turbines, high-pressure pumps, recent types of condenser and cooling towers, air pumps, steam accumulators and steam generating units have also been added.

Industrial Heat

ELEMENTS OF INDUSTRIAL HEAT, VOL. I (1933). *By John A. Randall and J. Warren Gillon, Rochester Athenaeum and Mechanics Institute. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 261 pages, 6x9 in. Clothboard covers. Indexed. Appendix, bibliography, and problems. Mollier diagram in back pocket. 76 diagrams, 17 tables. Price, $2.75.*

Little mathematical discussion and simple language make this text suitable for the beginner in heat engineering. Chapter I deals with fundamental relations between heat, mechanical and electrical energy. Chapter II deals with calorimetry, III with the effects of heat in producing expansion and contraction, and IV the effects of heat in producing changes of state. Chapter V treats of steam calorimetry, Chapter VI with heat transmission, VII fuels and combustion, VII with home humidification and Chapter IX elementary principles of thermodynamics.

Further problems are included in the appendix. Volume II, to be ready early next year, will deal with steam boilers, engines, turbines and auxiliary equipment, internal combustion engines and mechanical refrigeration.

Power Generation

ELEMENTS OF POWER GENERATION (1933). *By Arthur M. Greene, Jr., dean, School of Engineering, Princeton University. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 314 pages, 6x9 in. Clothboard covers. Indexed. 324 diagrams. Price $3.25.*

Boilers, generators, turbines, engines and governors form the subject matter of this text, which is written from the practical side rather than the theoretical. Its aim is to acquaint the reader with the various types of prime movers and associated equipment and to get him thoroughly familiar with proper terminology. Illustrations are good and the text is clear. This is a good text on elementary power problems.

BRIEF REVIEWS

HOW TO FIGURE OXWELDING AND CUTTING COSTS. *8 pages, 8½x11 in. Paper covers. Illustrations and tables. Published by Linde Air Products Co., 30 East 42nd St., New York, N. Y.*—Three different methods for computing material consumption, and the conditions under which each should be used, are shown in tabular form. Examples explain each method. Estimating cost of blowpipe operation for small jobs of welding, heating or cutting is simplified by a system of unit costs described.

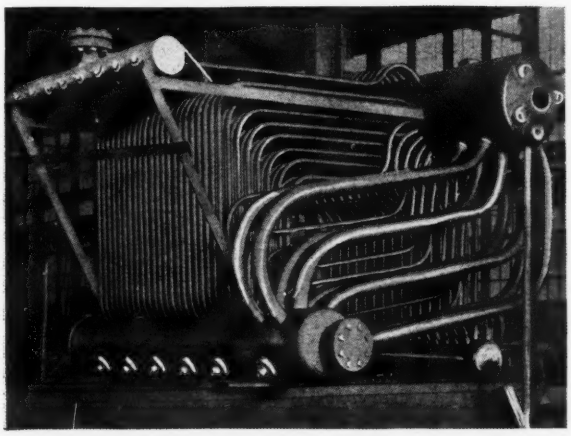
FEUERUNGSDECKEN (BOILER FURNACE ROOFS). *By Dipl. Eng. Karl Harraeus. Published by Carl Heymanns Verlag, Berlin W8, Germany. 108 pages, 6½x9½ in. Paper covers. Price 10 RM., bound, 12 RM.*—Printed in German. Many diagrams and a good bibliography of more specialized works on various phases of the subject.

AMERICAN STANDARD YEARBOOK, 1932-1933. *Published by the American Standards Association, 29 West 39th St., New York, N. Y. 44 pages, 8x10½ in.*—Contains 31 new national industrial standards, including the Safety Code for Floor and Wall Openings, Railings and Toe Boards (A12-1932); Inch-Millimeter Conversion for Industrial Use (B48.1-1933); Shaft Couplings, Integrally Forged Flange Type for Hydro-Electric Units (B49-1932); Specifications for Impregnated Paper Insulation for Lead-Covered Power Cables (C8.10-1933); Safety Rules for Installing and Using Electrical Equipment in Metal Mines (M24-1932); Abbreviations for Scientific and Engineering Terms (Z10-1932) and American Recommended Practice for Installation, Maintenance and Use of Piping and Fittings for City Gas (Z27-1933).

SCHRAUBENSICHERUNGEN. *By Dr.-Ing. Hugo Schoenich and members of the German Patent Office staff. 129 pages, 5½x9 in. Published by Carl Heymanns Verlag, Berlin, Germany*—One of a series of monographs under the general title, "Status of Technology." Presents a condensed picture of present state of the art of safety locks, based on some 4,000 patent descriptions from various countries. 29 pages of definitions and discussion, and general classification of descriptive material into 14 types of locking devices.

PURDUE NEWS—PUBLICATIONS OF THE ENGINEERING EXPERIMENT STATION AND THE ENGINEERING EXTENSION DEPARTMENT, PURDUE UNIVERSITY—A catalog listing research papers and prices. Available from the University at Lafayette, Ind.

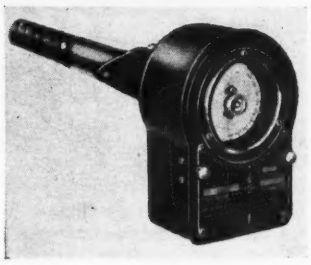
WHAT'S NEW IN PLANT EQUIPMENT



Small, High-Pressure Boiler

This small, oil-fired boiler produces saturated steam at 507 deg., maximum pressure being 715 lb. gage. Applicable where steam is used in process at boiler pressure and process is above boiler. Steam from boiler flows to process heating coils, is condensed there and condensate returns to boiler by gravity. Usual accessory equipment eliminated, no feed or circulating pumps. Small volumetric capacity of heating coil lessens fluctuation of drum water level. Boiler consists of three drums connected by bent tubes and built around water-cooled furnace. All tubes within setting are steam-generating, circulating tubes outside setting between upper and lower drum. Combustion gases make two passes across boiler water tubes and single row of steam-drying tubes. Steam removed from drum through steam-drying tubes connected to manifold pipe outside boiler setting. Boiler drums forged steel, with handholes. All water tubes 1 in. O.D., except three rows of 1½ in. O.D. tubes connecting upper drum with drum below—one row downcomers, one row generating tubes in front of furnace and one row in rear of furnace. Downcomers between upper drum and other lower drum are 3 in. O.D. Unit fired by single oil burner in side wall.

Foster Wheeler Corp., 165 Broadway, New York City.



Indicating Temperature Controller

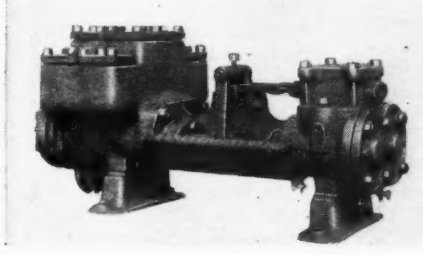
Type L48-4 temperature controller (shown) L68 and L93 controllers indicate and control temperature of air, gases, or liquids in ducts, ovens, tanks, vats, pipes etc. Are self-contained actuating electrical contacts which govern mechanisms of heat supply, pumps or fan operation, etc., and provide means of insuring constant, uniform temperature at control point. Three models, varying in assembly of temperature-sensitive element. Each can be furnished for various electrical control circuits. Bi-metal helices provide operation. Bulletin Page L39.

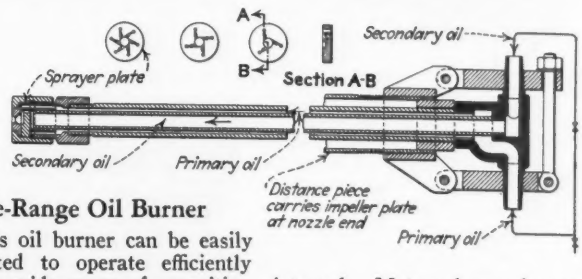
Minneapolis-Honeywell Regulator Co., 2702 Fourth Ave., Minneapolis, Minn.

Pot-Valve-Type Steam Pump

This small high-pressure pump is a duplex direct-acting steam unit with pot-valve-type fluid end. Master size is 4½x 3x4, but either 2 or 2½-in. diameter liners and fluid pistons may be substituted for the 3-in. to suit service conditions. Used for pumping oil, for small oil lines or for water supply where small quantities of water must be pumped against moderately high pressures. Bulletin P-36.

Gardner-Denver Co., Quincy, Ill.





Wide-Range Oil Burner

This oil burner can be easily adjusted to operate efficiently over a wide range of capacities. Barrel assembly of burner, known as "B & W Wide-Range Mechanical Atomizing Oil Burner," is shown. This barrel assembly is used in standard B & W Mechanical-Atomizing Oil Burner register or as oil-burning element of B & W Multifuels Burner. Fuel oil is delivered to burner tip through two passages, outer annular passage carrying primary oil stream and center oil barrel carrying secondary oil. Both primary and secondary oil meet at one nozzle and a sprayer plate at burner tip. Changes in capacity with given nozzle and sprayer plate are secured by operating at low capacities with primary oil alone, and at higher capacities with primary and secondary oil together. Capacity variation of four to one with any one combination of a sprayer plate and its nozzle. Tests show excellent atomization throughout range, and oil flow from burner nozzle is in form of practically perfect cone.

The Babcock & Wilcox Company, 85 Liberty St., New York City.

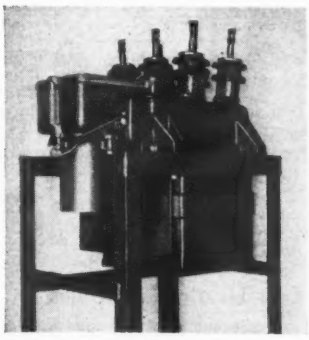
Watt-Hour Demand Meters

Type DG-1 combines watt-hour meter and recording demand meter. Demand mechanism is of "block-interval" type, recording on strip-chart demand over definite time interval. Record made on chart for each interval, with ⅛ in. between these lines for all ratings. A hook or quirk at end of ink line definitely indicates exact value of demand. In addition, chart is advanced continuously, so that slope of line on chart gives indication of variation in magnitude of load during time interval. Meters have characteristics of Type I-16 meter, including high torque and complete temperature compensation for all power-factors.

General Electric Co., Schenectady, N. Y.

Automatic Reclosing Breaker

Self-contained reclosing equipment for lightly loaded feeders is incorporated in Type FO-22 breaker, 7,500 volts, with a 50,000-kva. interrupting capacity rating on the 2-OCO duty cycle. Automatic reclosing equipment mounted within breaker mechanism housing makes self-contained unit. It operates over a CO 1 sec., OCO 2.8 sec., OCO lockout duty cycle. Breaker solenoid-operated from a.-c. source by means of a Rectox in distribution transformer tank. If desired, operating transformer and Rectox can both be mounted in same tank, to make only two equipments to be mounted. Breaker tripped by series coils in breaker tank. Equipment built for pole mounting, but can be supported on framework located on floor.



Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Odor Filter

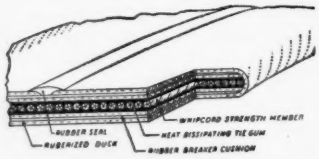
Used in ventilating and air-conditioning systems, industrial systems for removing odors harmful to process or polluting discharge atmosphere, and in certain special applications. Works on gas-mask principle, passing air through bed of granular activated cocoanut-shell carbon. When carbon has

absorbed odors to capacity, it can be reactivated. Supplied in unit cells mounted in standard cabinets holding four cells. Air-handling capacity per cell is 125 c.f.m. at face velocity of 54 ft. per min. Static resistance, 0.5 in. water gage. Weight per cell, filled, 29 lb.

Consolidated Air Conditioning Corp., 192 Lexington Ave., New York, N. Y.

Whipcord Transmission Belt

Of endless-wound whipcord construction and without inelastic stretch, this belt, known as Condor Whipcord, was developed for high-speed, high-tension drives. Single-layer



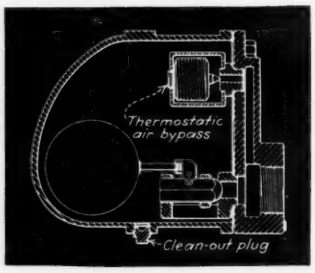
cord section is claimed equivalent to six duck plies in strength, while many times as flexible. Widths from 1 to 12 in.; lengths up to 75 ft.

Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J.

Low-Headroom Boiler

Designed to replace antiquated 72-in.x18-ft. H.R.T. boilers used in breweries, this 1,500-sq.ft. unit is probably lowest of low-headroom boilers so far designed. Has sufficient furnace volume for 225 per cent rating at 1 cu.ft. per developed hp. No. 1 and No. 2 tubes serve to keep the furnace temperature within safe limits. Three quarters of steam is generated in rear drum, and in passing over tube No. 16 picks up some superheat. Boiler is 18 ft. 2½ in. long and brickwork is same as for regular 1,500-sq.ft. H.R.T. boiler. Can be built for whatever pressure is desired up to 400 lb.

Wm. Bros Boiler & Mfg. Co., Minneapolis, Minn.



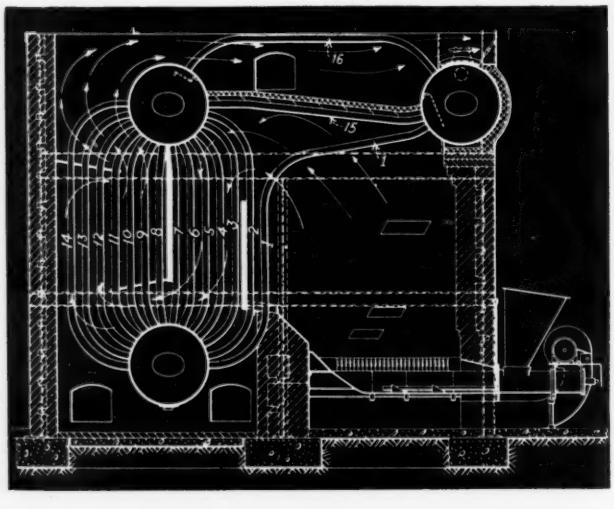
Float and Thermostatic Trap

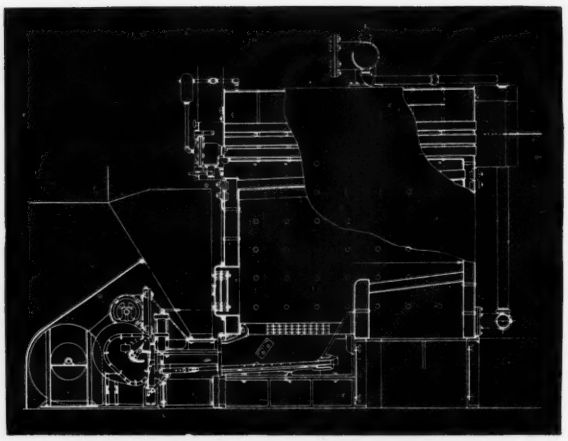
Designed especially to handle condensation in large quantities and in sudden rushes, as in unit heaters, pipe coils, etc. 1½-in. inlet and outlet, both in front and 3 in. apart vertically. All working parts on cover, accessible by removing trap body. Pipe connections not disturbed. Boss provided on top of body in line with clean-out plug for installation of gage glass if desired. Standard trap good for pressures 0-10 lb., but trap can be furnished for pressures of 10-60 lb. Thermostatic valve to prevent air binding.

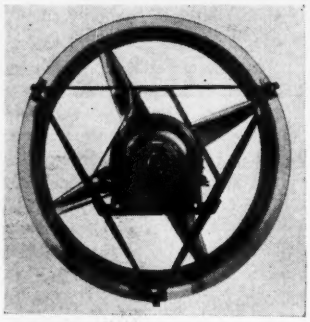
The Sarco Co., New York, N. Y.

Ventilating Fans

Sizes from 16- to 36-in. diameter, both 2 and 4 blade. Capacities range from 1,450 c.f.m. for 16-in., 2-blade unit, to 18,000 c.f.m. for 36-in., 4-blade type. Illustrated design is of units above 24 in. in diameter. Blades aluminum drop forgings. Motor supports sheet steel welded to form rigid structure with minimum resistance to air flow. Intake rings of sheet steel rolled to shape, then welded to form continuous ring,

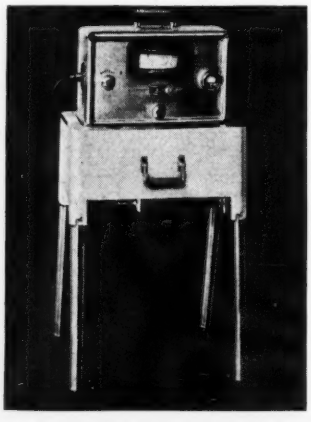






similar in shape to intake end of aerodynamic wind tunnels. Thus ring decreases resistance to air flow and reduces tip losses. Called "Venturiflow."

Bendix Products Corp., South Bend, Ind.



Combustible Gas Analyzer

Model RZA measures combustible components of gaseous mixtures continuously and automatically. Particularly for furnace atmospheres. No chemicals or water. Operates from 110- or 220-volts. Direct reading in percent of combustible gases. Time lag less than 20 sec., and unit unaffected by room temperature and voltage changes. Portable, but unit also available for stationary installation. Operates on principle of combustibles burning catalytically along heated resistance wire, which forms one arm of Wheatstone bridge.

Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.

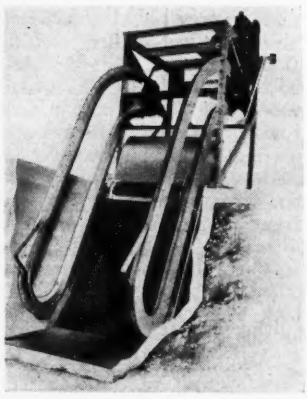
Stoker-Boiler Unit

Spencer combination stoker and boiler is balanced unit, consisting of automatic underfeed ram-type stoker and steel heating boiler, furnished in capacities from 6,400 to 40,000 sq.ft. of steam radiation. Designed for smokeless burning of high volatile coal. Boiler proper delivered in two units with bridge wall built in, thus eliminating expenses of bricking. Boiler built by Spencer Heater Co., division of Cord Corp., stoker by Riley Stoker Corp. Unit sold by

Spencer Heater Co., Williamsport, Pa.

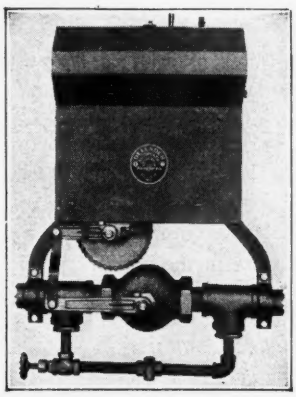
Self-Cleaning Bar Screen

Automatic, this screen has clear opening from side to side in submerged portion and has no sprockets or shafts at bottom of channel; chain floats around large-radius curves in guides. Scraper enters channel back of accumulated refuse, engaging bottom 2 ft. ahead of screen; this insures cleaning as teeth drag forward over bottom and up screen. Rake teeth pass



entirely through screen to top, then engage automatic wiper. Control mechanism provides continuous or intermittent operation at intervals from 2 sec. to 1 hr. Differential float control can be furnished if desired. Shear pins permit release of mechanism in emergency.

Jeffrey Mfg. Co., Columbus, Ohio.



Motor-Operated Pressure Regulator

Actuated by pressure, vacuum, temperature, volume, time or flow, and usable on horizontal and vertical pipe lines, these units operate chronometer valves. Unit illustrated on horizontal pipe, operating a valve with ⅜-in. bypass to be set for minimum or slow speed of fan or stoker engine. Can be used also as pump governor or for controlling reducing valve. Adjustable compensating type with face plate on front of cogwheel having stops. Can be supplied with 5 different face plates, with 16, 8, 4, 2 stops or a blank that permits full travel forward or backward on one contact change. Heavier or lighter spring can be supplied for compensator to give unit ability to make any of above number of stops on any change in pressure from 1 to 10 lb. Actuating medium is hollow coil spring, adjustable from outside, so that regulator will work from 20 in. of vacuum to 250 lb. pressure.

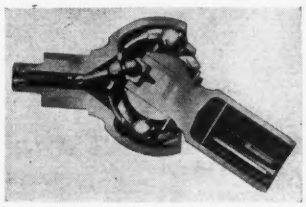
Defender Automatic Regulator Co., 308 S. 8th St., St. Louis, Mo.

Constant-Support Pipe Hanger

One problem of pipe installation is to provide full support for horizontal piping that has considerable vertical movement due to expansion of risers as pipe temperature changes. "Genspring" pipe hanger is designed to provide a constant supporting force for pipe during vertical movements of as much as 2 in. without permitting non-axial stresses to develop in pipe joints or other parts of line. It also permits horizontal movements.

Pipe is supported by levers which compensate for changes in supporting effort of springs as they are deflected by vertical movements of pipe line, so that in every position levers balance supporting effort with load, and no part of load is at any time unsupported. Hangers supplied to support all loads from 500 to 7,000 lb. accommodate vertical movements up to 2 in. and weigh approximately 160 lb. Greater loads and movements provided for on special order.

General Spring Corporation, 11 West 42nd St., New York.



Universal Joint

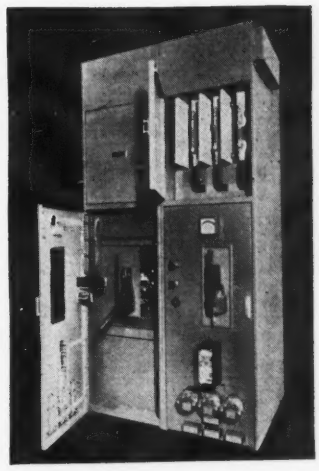
Constant angular velocity, angularity as high as 37½ deg., simple construction and high efficiency are characteristics of "Rzeppa" ball-bearing universal joint. Adapted to all types of mechanical units. Nominal shaft diameters 1 to 2¼ in., with ratings 5,600 to 63,000 in.-lb. Two driving members separated by close-fitting ball cage, all three with spherical contact surfaces. Six balls inserted into corresponding half grooves of driving members; thus plane of driving balls always bisects angle between the connecting shafts, resulting in constant angular velocity. All parts case-hardened steel. Also 15-deg. angularity "disc-type" unit available.

Gear Grinding Machine Co., Detroit, Mich.

Steel-Enclosed Cubicle

Standardized 7.5-kv. steel enclosed cubicles can be assembled in any desired number of units. Manually solenoid or motor-operated oil circuit breakers are trip free, and operating mechanism interlocks with hinged door of disconnecting switch compartment. Bus in top of compartment provided with removable end covers for ready connection to other units. Left cubicle is incoming line unit; right is feeder unit. Relays, meters, instruments and control switches attached to hinged doors for ease in wiring.

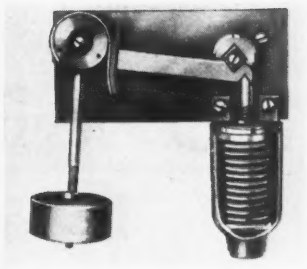
Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.

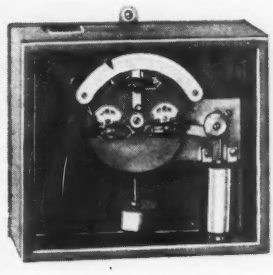


Air Cooling and Conditioning Unit

"Comfort Conditioner" uses two extended-surface copper coils, one for steam or hot water for heating, the other for cold water or other refrigerant. Heating coil can be omitted if desired. Three sizes, 2-, 4- and 6-ton cooling capacity, with B.t.u. range of 24,000 to 72,000 per hour, average temperature drop 28 deg. Heating coils have B.t.u. range of from 77,500 to 232,000 per hr. No moving parts visible; pipe connections at back. Casing non-sweating, sound-insulating board.

Buffalo Forge Co., Buffalo, N. Y.

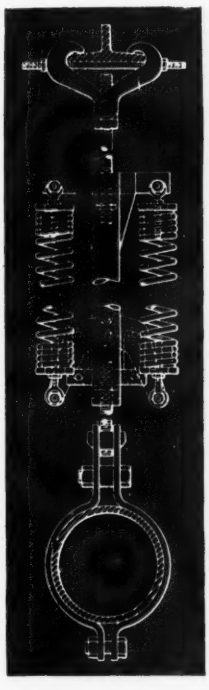


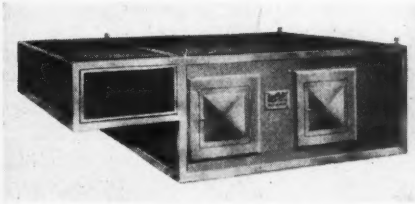


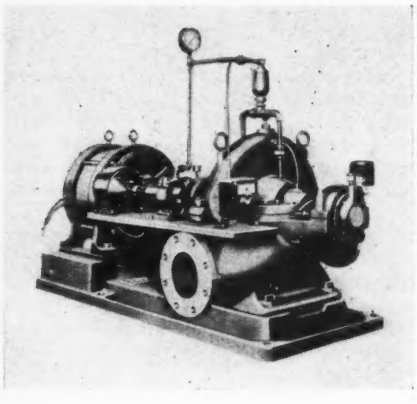
Rotary Multi-Contact Control

"Roto-trol" applies old principle of springless scale to pressure control. Pressure applied to metallic diaphragm at right. upper view, causes counterbalancing pendulum to move through arc of about 50 deg. to point of balance. Disk on front face of pendulum fulcrum carries several mercoid switches, each also adjustable to close or open at a given point of pendulum swing. Thus control can handle any number of separate circuits up to six and can operate them in any desired sequence. Capacities 0 to 445 ft. head of water; differential setting, 1 to 60 per cent. Type A (lower photo) has capacity of 0-225 ft. (100 lb.), differential setting of 3-60 per cent.

Water Level Controls Co., 765 Hampden Ave., St. Paul, Minn.







Self-Priming Systems for Centrifugal Pumps

This system, for automatically priming Pennsylvania centrifugal pumps, is efficient and at the same time assures pump safety. Small motor-driven rotary vacuum pump unit, mounted on centrifugal pump and arranged to evacuate air in pump and its suction line, is started either by push button or remote control, as by change in water level or head, and when pump is fully primed motor is started. Building up of normal pressure in discharge line stops vacuum pump, but should pump lose its prime at any time it is automatically stopped, vacuum pump started, and the cycle of priming repeated. Suitable protective controls to prevent continual repetition of priming cycle.

Pennsylvania Pump & Compressor Co., Easton, Pa.

POWER LINES

Goodyear Begins Modernization of Akron Power Plant

During the next few months, Goodyear Tire and Rubber Co., Akron, Ohio, will spend more than a half-million dollars in the purchase of new power-plant equipment and in construction of a new power-plant building, representing one of the largest major construction improvements in the Akron area since the depression.

A portion of the present power-plant building, back of the general office building, is to be torn down and six boilers removed, some of which have been in service since 1910.

The building itself, of conventional brick-steel construction, will cost approximately $20,000 and will provide employment for 100 men during the course of erection. Award of the building contract will not be made for at least another month.

The new building will house a single boiler and air preheater capable of generating 300,000 lb. of steam per hour at 800-lb. pressure and a temperature of 740 deg. F. Contract for the boiler, which will cost $250,000, has been awarded to Babock & Wilcox Co.

Coal from Goodyear's Adena mines will be used as fuel after being pulverized in a ball-type mill and fired through horizontal cross-tube burners. The furnace will be provided with water-cooled walls and a slag-tap bottom for ash removal. The molten ashes are cooled, solidified and then broken up by action of a water spray, after which they are taken by conveyor to cars to be hauled away. About $25,000 will be spent on the ash-handling equipment.

Water-softening equipment, to remove any scale-forming ingredients from water for boiler use, will cost $25,000.

Approximately $30,000 is to be spent on equipment for controlling the amount of water, fuel and air fed to the boiler. Extremely heavy piping will be necessary for use with the boiler and the new turbine, and it is estimated the piping installation will amount to $30,000.

Steam generated by the boilers will supply a new 10,000-kw., 2,300-volt turbine generating unit, costing $140,000, contract for which was recently awarded to General Electric. The turbine will exhaust into the 100-lb. factory steam main, to be utilized for heating, curing, etc. Steam at 200 lb. pressure will be extracted from the turbine and used in low-pressure turbine-generating units already in use.

Additional electrical equipment, including switches, panels, controls, etc., will cost approximately $250,000.

Many other small miscellaneous items will of necessity be purchased during construction. All of the work—construction of the building, erection of the turbine and boiler, and installation of electrical equipment, piping, etc.—is expected to progress simultaneously; and Nov. 1 has been set as the date for the new plant to begin operation.

In every possible instance, work is to be let to concerns in the Akron area, thus helping the local employment situation. All of the engineering work will be handled by Goodyear's own engineering department.

Roosevelt Favors N.I.R.A. Aid To Municipal Power Projects

The question is frequently asked whether municipal power-plant projects are eligible to loans under the Public Works and Construction Section of the Industrial Recovery Act. Based on President Roosevelt's own statement last month, the answer is definitely "yes," provided the projects are self-liquidating. Specifically exempting the statement from the rule that the President may not be quoted directly, Mr. Roosevelt, in a reply to a question addressed to him in the press conference on July 14, said "Municipal light plants will receive very favorable consideration. Of course, they must be self-liquidating."

The portion of the law under discussion permits the government to lend, under certain restrictions, up to 30 per cent of the cost of labor and materials used.

Supplementing President Roosevelt's statement Secretary Ickes said at a later press conference, "I suppose in some cases they (municipal power plants) will compete with existing plants."

Asked whether that would interfere with approval of a municipal project by the Public-Works Board, Secretary Ickes replied: "Not at all. Each will be considered on its merits."

Secretary Ickes also remarked that the Public-Works Board would not be precluded from looking into any municipal power-plant projects by the fact that the R.F.C. had turned them down. He was speaking, of course, with reference to such projects as were in the R.F.C.'s portfolio.

McNinch Named Chairman Federal Power Commission

Frank R. McNinch, vice-chairman of the Federal Power Commission for several months, has been appointed chairman of that body to succeed George Otis Smith, who vacated that position in acquiescence to the desire of President Roosevelt to have a man of his own selection. Mr. Smith's resignation was only as chairman, but it is expected in authoritative circles, that he will leave the commission entirely within 90 days. Mr. McNinch's designation as chairman was confirmed by the commission by a unanimous vote. The commission then selected Basil Manly, who was appointed in May by President Roosevelt, as vice-chairman. Mr. Smith was for nearly twenty-five years director of the Geological Survey. It was in 1930 that he became chairman of the commission.

Standards Bureau Activities Transferred to A.S.A.

Certain activities of the National Bureau of Standards have been transferred to the American Standards Association, Engineering Societies Bldg., New York, as the result of an arrangement worked out between Secretary of Commerce Roper and Pres. Howard Coonley of the ASA. These activities include: Division of Trade Standards, Division of Specifications, Division of Simplified Practice, Building Code and Plumbing Code Sections of Building and Housing Division, Safety Code Section.

Inside the B & W Field Fabricating Plant at Boulder Dam

Fully equipped to fabricate by welding, and to test by X-ray, 14,500 ft. of pipe 8½ to 30 ft. in diameter, from steel plate from ¼-in. to 2¼ in. thick, this plant is 90x520 ft. Work on the floor is 8½-ft. diameter pipe first of the huge order to be executed for the Government by Babcock & Wilcox.

Heating & Ventilating Exposition announced

The Third International Heating and Ventilating Exposition will be held in Grand Central Palace, New York City, February 5 to 9, 1934. The last Exposition was held in Cleveland, in 1932, and the first one took place in Philadelphia, in 1930. The Third Exposition, like its predecessors, is under auspices of the American Society of Heating & Ventilating Engineers, who also will hold its meeting in New York, during the week of Feb. 5.

Conduct of the Exposition and all details of exhibit arrangement and leasing will be in charge of the International Exposition Company of Grand Central Palace, New York, and will be under direction of Charles F. Roth, manager, who was responsible for the earlier expositions at Philadelphia and Cleveland.

Financial Situation Topic At Stevens Conference

At the third annual economic conference for engineers, to be held at the Stevens Engineering Camp, Johnsonburg, N. J., Aug. 12-20, the general theme will be the financial situation. A number of speakers of note will be present, including authorities on the many phases of the question. The conferences are sponsored by the alumni associations of a number of eastern schools, by the A.S.M.E. and the A.I.Ch.E. Further information can be obtained from the President's Office, Stevens Institute of Technology, Castle Point, Hoboken, N. J.

System of Viscosity Classifications for Industrial Lubricants

A wide interest throughout industry is promised for the new program of establishing a viscosity classification system for industrial lubricants. This subject was brought up for discussion at the A.S.M.E. Lubrication meeting held at Pennsylvania State College recently, when a gathering of over 100 representatives of users and manufacturers of lubricants unanimously recommended that an American Standards Association Committee be organized to develop a simple significant and readily interpretable system of viscosity classification.

The Lubrication Engineering Committee of the A.S.M.E. Petroleum Division met at the conclusion of the meeting and decided to appoint two special subcommittees to carry on the work of viscosity classification, pending the appointment of the A.S.A. committee. One of these committees is to be known as a Refinery Viscosity Classification Committee, with Dr. A. E. Becker as chairman, and with three vice-chairmen, representing the Eastern Mid-Continent, and Pacific Coast sections. Capt. W. C. Thee, of the U. S. Army, was chosen secretary. This committee's work is to develop further the suggestions made by Dr. Becker and Mr. Larson and to secure from oil refiners their comments and suggestions.

The second committee formed was on Viscosity Needs of Users. The work of this committee will be to secure information on viscosity classifications now being used and on the necessary factors to be included in such classifications. William F. Parish was chosen as chairman of this committee with Harvey Konheim as secretary.

Treasury Calls on Engineers for New Building Program

Private architects and engineers throughout the country will be engaged by the Treasury Department to prepare plans and specifications for a large Federal building program which may reach a total of $200,000,000. L. W. Robert, Jr., Assistant Secretary of the Treasury, has adopted this policy in order that professional men who have not had employment will benefit by the large expenditure for the new Federal buildings, the design and construction of which come under the authority of the Supervising Architect's Office of the Treasury.

For the purpose of spreading employment as far as possible among architects and engineers who, preferably, have had some previous experience in public-building work, Mr. Robert has requested the cooperation of American Engineering Council and the American Institute of Architects in enrolling qualified individuals and firms.

Any qualified engineer desiring to participate in the Treasury Department's building program should send to L. W. Wallace, Executive Secretary, American Engineering Council, 744 Jackson Place, N. W., Washington, D. C., a complete statement, in duplicate, of his professional record, with a citation of significant reference.

Coal Classification Committee Announced

A new subcommittee on the Application of Scientific Classification of Coal has been appointed by W. H. Fulweiler, chairman of the Technical Committee on Use Classification, a subdivision of the Sectional Committee on Classification of Coals (M20) under the procedure of the American Standards Association The new subcommittee will act as a correlating committee to harmonize the scientific classification of coal as prepared by the Technical Committee on Scientific Classification with the practical use classification of coal as worked out by the Technical Committee on Use Classification.

T. W. Harris, Jr., division purchasing agent, E. I. duPont de Nemours & Co., Wilmington, Del. is chairman.

COMING MEETINGS

Nat'l Ass'n Power Engineers — National Convention, in conjunction with Niagara Frontier Power Conference & Mechanical Exposition, Buffalo, N. Y., Auditorium, Aug. 28-Sept. 2. Fred W. Rayen, Secretary, 1140 Lake St., Oak Park, Ill.

A.S.M.E. Oil & Gas Power Div.—6th National conference, Ritz-Carlton Hotel, Atlantic City, N. J., Aug. 23-26. Louis R. Ford, chairman, 29 West 39th St., New York City.

Second American Exposition of Brewing Machinery, Materials & Products—Auditorium Hotel, Chicago, Ill., Sept. 23-Oct. 1, together with meeting of Master Brewers Ass'n of America. James R. Nicholson, 55 West 42d St., New York, N. Y., secretary. Felix Mendelsohn, managing director of exhibit.

American Welding Society—Annual Fall Meeting, Book-Cadillac Hotel, Detroit, Mich, Oct. 2-6. Details, A. W. S., 29 West 39th St., New York City.

Ass'n Iron & Steel Elec. Engrs.—Mechanical, Combustion, Lubrication, Electrical and Safety Divisions, 29th Convention & Iron & Steel Exposition, Wm. Penn Hotel, Pittsburgh, Pa., Oct. 17-19.

National Metal Congress—Fifteenth National Metal Congress and National Metal Exposition, Detroit, week of Oct. 2.

Sixteenth Annual Conference on Industrial Relations—Silver Bay on Lake George, N. Y., Aug. 23-26. Executive Secretary, E. C. Worman, 347 Madison Ave., New York.

Professional Engineers Plan Code Under NIRA

A committee has been appointed by H. G. Balcom, president of the New York County Chapter of the New York State Society of Professional Engineers, to look into the question of the preparation of a Code of Ethics and Fair Practice for Professional Engineers, under the N. I. R. A., and its submission to the Federal Authorities at Washington. The committee is composed of:

John W. Pickworth, C.E. *(Chairman)*, 45 W. 45th St., N. Y. C.; Maurice Goodman, E.M., 90 W. Broadway, N. Y. C.; R. A. Pendergrass, C.E., 39 Broadway, N. Y. C.; Victor J. Cucci, M.E., 347 Madison Ave., N. Y. C.; Harry S. Arnold, E.E., Chrysler Bldg., N. Y. C.; Edwin A. Kingsley, M.E. *(Secretary)*, 101 Park Ave., N. Y. C.

International Combustion Sale Held Valid by Court Ruling

The Federal Circuit Court of Appeals has affirmed the decrees of sale, with one modification, of the properties of International Combustion Engineering Corp. to International Combustion, Inc., a new company formed by Superheater Corp. The court held that the sale was valid and that there was no abuse of discretion by the District Court, but modified the decrees to this extent. The Court remanded to the District Court for further consideration the 30,000-share stock payment to Hayden, Stone & Co. as compensation for underwriting the new corporation's stock.

George L. Bourne will be chairman of the board of the new company; Frederick A. Schaff, president; Joseph V. Santry, R. M. Gates, John Van Brunt and M. H. Isenberg, vice-presidents; H. H. Berry will be treasurer and George W. Grove secretary and assistant treasurer.

OBITUARIES

R. H. Barber, superintendent of steam plants, International Paper Co. for the last eight years and for fifteen years prior to that chief engineer of New Bedford Gas & Edison Light Co., died July 12 at Hull, Que., as the result of an automobile accident. He was one of the early members of the Prime Movers Committee, N.E.L.A., and was widely known as an authority on steam-plant design and operation.

Elmer D. Barry, chief engineer of Demerara Boxite Co., Ltd., died in British Guiana on July 23, where he had been stationed for the past five years. His home was at Dorchester, Mass., and he was a native of Vermont.

John E. Ercanbrack, 60, chief engineer of Bell & Gossett Co., Chicago, Ill., died

suddenly at his home there June 8. He had been actively engaged in the plumbing and heating industry for over 40 years.

FREDERICK C. FARNSWORTH, 50, president and general manager of Farnsworth Co., Watertown, N. Y., died suddenly of heart trouble at Minneapolis, Minn., July 9. Mr. Farnsworth, accompanied by H. M. Raub, left Watertown about six weeks ago on a business trip into the Middle West and was in Minneapolis when he was stricken. Farnsworth Co. manufactures and markets steam plant equipment.

WILLIAM T. HENRY, 88, industrial architect and engineer of much prominence in the textile-mill power field, died at Fall River, Mass., July 22. He was responsible for the design of about 70 mill plants in the Fall-River and outside districts. About six years ago he retired.

WILLIAM E. WILLIAMS, 73, for the past 25 years a stationary engineer employed by Amoskeag Mfg. Co., Manchester, N. H., died July 28.

GEORGE F. KENDALL, 77, for many years head of Charles River Iron Works, Kendall Square, Cambridge, Mass., died at his home in that city July 28.

FRANK W. PEEK, JR., 49, chief engineer of the Pittsfield, Mass., works of the General Electric Company and one of the company's specialists in high-voltage work, was killed July 26 when his automobile was struck by a train near Gascones, on the Gaspé peninsula of Canada. Mr. Peek lived about an hour after the crash; Mrs. Peek, who was with him on a vacation trip, was only slightly injured. Mr. Peek was probably best known, both to the electrical engineering profession and the public, by his work in the field of lightning research. He had continued much of the general line of investigation begun in the early years of this century by the late Charles P. Steinmetz, under whom Mr. Peek worked for a period during the early part of his career.

PERSONALS

MAJ. A. E. CARPENTER, first vice-president and treasurer, E. F. Houghton & Co., 240 West Somerset St., Philadelphia, Pa., has resigned the latter office and has been elected general manager. GEORGE W. PRESSELL, second vice-president and secretary, has resigned the secretaryship and been elected assistant general manager and director of sales. DR. R. H. PATCH, director of plants, has been elected treasurer, and A. E. CARPENTER III, assistant to general sales manager, has been elected secretary. GEORGE S. ROGERS, formerly assistant general sales manager in charge of the St. Louis and Chicago offices, has been elected general sales manager with headquarters in Philadelphia. Sales for May have been reported the highest in over a year, being 24.5 per cent above those of the same month of 1932.

CHARLES M. BOLING, representative of the Dampney Co. of America, Hyde Park, Boston, Mass., in Detroit, has moved to Cleveland, and will cover both territories there.

HERBERT J. DRANE, of Florida, has been confirmed by the U. S. Senate as a member of the Federal Power Commission.

W. J. ANDREWS, for 15 years with Advance Packing & Supply Co., is now heading the industrial division of metallic and fibrous packing for Felt Products Manufacturing Co., 1508 Carroll Ave., Chicago, Ill.

JOHN J. FELSECKER has been added to the consulting staff of D. W. Haering & Co., water consultants, 3408 West Monroe St., Chicago, Ill.

EDWARD J. BADE, in the laboratory of Dearborn Chemical Co., 310 S. Michigan Ave., Chicago, Ill., for the past six years, has been transferred to the sales department, succeeding A. C. Herrmann on the south side of Chicago. Mr. Herrmann is resigning to go into business with his father.

L. W. GROTHAUS, formerly general representative in charge of the sales organization, Allis-Chalmers Mfg. Co., Milwaukee, Wis., has been appointed assistant to the president. His immediate duties will be to direct the company's interests in matters pertaining to the NIRA as they relate to commercial problems. He has been with the company since 1904, when it acquired Bullock Electric Mfg. Co. Walter Geist assistant manager of the Milling Machinery Dept. since 1928 and with the company since 1909, succeeds Mr. Grothaus as general representative.

L. E. JEANNERET, special representative of The Babcock & Wilcox Tube Co., is acting temporarily as district sales manager of the Detroit territory, replacing J. E. Polhemus, former manager.

JOEL D. JUSTIN, formerly hydro-electric engineer of United Gas Improvement Co., has opened an office for practice of his profession at 246 S. 15th St., Philadelphia, Pa.

FRED W. LINAKER, for many years chief engineer and lately vice-president of the Vulcan Soot Cleaner Co., has been elected vice-president of the Bayer Co., 1505 South Grand Blvd., St. Louis, Mo.

H. R. ORWICK, formerly general manager of Corundite Refractories, Inc., Massillon, Ohio, for 16 years, has joined the Massillon Refractories Co., Massillon, Ohio, as special refractory engineer.

DR. WALTER N. POLAKOV, industrial and management engineer of New York, has been appointed to the engineering staff of the Tennessee Valley Authority. He is credited with originating the remote control idea for industry and developed the "straight-bar" chart system of planning and control used by the Government during and since the war. As power expert with the Shipping Board Emergency Fleet Corp. during the war, Dr. Polakov handled the problem of power supply for the eastern coast and was in charge of graph control of export and import.

T. F. THORNTON has been appointed sales manager of the Detroit district, with headquarters in the Ford Building, Detroit, for Babcock & Wilcox Tube Co., Beaver Falls, Pa. For the past six years he has had charge of the sale of tubular products of Pittsburgh Steel Co. in the Detroit district.

L. A. S. WOOD, manager lighting products division, Westinghouse, with headquarters in Cleveland, has been elected vice-president of the Illuminating Engineering Society.

JOHN J. O'BRIEN, president of Byllesby Engineering & Management Corp., announces that Harold L. Geisse, former president of Wisconsin Valley Electric Co., has joined the operating staff of Byllesby Engineering & Management Corp. in Chicago. Mr. Geisse has had extensive experience in the public-utility industry. Since 1922 he has managed Wisconsin Valley Electric Co. properties, continuing to act in a managerial capacity when these properties were taken into the Standard Gas & Electric Co. system in 1927. The recent merger of Wisconsin Valley Electric Company with Wisconsin Public Service Corporation has made possible this appointment of Mr. Geisse.

WARREN A. EDSON has been appointed chief of the newly organized smoke inspection division of the Massachusetts Department of Public Utilities, with headquarters at 100 Nashua St., Boston. Mr. Edson has been in the service of the division since 1911. He headed its inspection service from 1915 to 1930, when the division was expanded to cover scrutiny of boiler plant designs under David A. Chapman, recent head of the work. Recent legislation curtailing the scope of the division led to the resignation of Mr. Chapman, transfer of offices to the new Public Works Department building of the state, and the reappointment of Mr. Edson.

BUSINESS NOTES

ASHTON VALVE CO., 161-179 First St., Cambridge, Boston, Mass., has appointed several new agents for its line of safety valves, steam gages and kindred appliances. They are: Power Equipment Co., 1352 Madison Ave., Memphis, Tenn.; O'Brien Equipment Co., 2726 Locust Blvd., St. Louis, Mo.; Rossman Industrial Supply Co., 3150 Elliott Ave., Seattle, Wash.; Garrett Burgess, Inc., 5050 Joy Road, Detroit, Mich.; Proctor Engineering Co., Inc., 28 South Gay St., Baltimore, Md.

MASON REGULATOR CO., Boston, and Neilan Co., Ltd., Los Angeles (subsidiary of Mason Co.) have consolidated. The name of the new company is the Mason-Neilan Regulator Co., as announced in *Power* recently. Engineering, manufacturing and sales departments of the companies have been combined at 1190 Adams St., Boston, Mass.

MCVOY-HAUSMAN CO., with offices in the Brown-Marx Bldg., Birmingham, Ala., has been formed of the combined sales agencies formerly known as James L. McVoy and Hausman-Harwick Machine Tool Co. The agency represents Cleveland Worm & Gear Co., Farval Corp., and similar companies.

CHAIN BELT CO., Milwaukee, Wis., has moved its St. Louis office to 5475 Cabannae Ave.

RILEY STOKER CORP. has moved its Pittsburgh office from 1419 Farmers Bank Bldg., to 1420 Investment Bldg., 239 Fourth Ave. Van A. Reed, Jr., and L. C. Frohrieb will be in charge of the new office beginning July 1.

HOPKINS & GOVE has been formed at Waltham, Mass., by Raymond A. Hopkins and Lewis P. Gove, formerly with Stone & Webster Engineering Corp., Boston, Mass., as electrical and mechanical engineers in power problems for industry.

STRAWS

Pointing the way the business wind blows

Baltimore City Hospital is considering returning to private plant electrical generation. Some years ago, power was privately generated, but when the engines became obsolete, they were junked, the equipment convertd to a.c., and power purchased from the local utility. Two years ago, the local union of the I.U.O.E. had a survey made and presented to the City Administration which showed possible savings of $13,000 per year with a private plant. Last year, increases in hospital steam demand exceeded plant capacity. In planning modernization, the union actively supported generating equipment. This was soon authorized by the City Council.

Specifications then existing included such expensive items as push-button, motor-operated windows, glazed brick, concrete roads, automatic coal- and ash-handling equipment, etc. By paring off unnecessary expenditures, a saving of $26,000 was made in the total plant estimate. The Public Improvement Commission authorized an additional $37,000, making $63,000 available for generating units, which are expected to cost somewhat less. Savings estimated by the city engineering force are approximately $8,000 per year.

The new plant will contain three, 250-lb., 4,000-sq.ft. boilers supplying 126-lb. steam at 180 deg. F. superheat. Room will be provided for steam-electric units, but they will not be installed this year. Records of the steam and electric loads will be taken for a year, so that required capacities can be accurately gaged before purchase.

Austin, Texas, is considering a financing program of $700,000, for construction of a new electric light and power system, with power susbtations and distribution facilities.

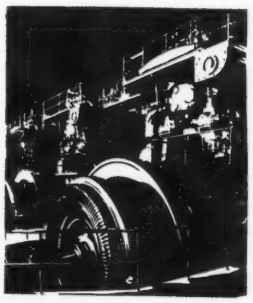
Two Indiana municipalities are discussing proposed construction of municipal electric light and power plants. Newcastle is considering a steam-electric generating station, with distributing facilities, estimated to cost about $450,000; Alexandria proposes a station to cost approximately $240,000, with prime movers and accessories.

Bureau of Reclamation, Denver, Colo., is asking bids until Aug. 25 for one 120-in. dia. and four 168-in. dia., butterfly valves, with complete operating mechanisms, with alternative bids for two valves of first-noted size and eleven valves of last-noted diameter, for installation at Boulder power plant, Boulder Canyon, Nev. (Specification 544).

I. G. Farbenindustrie of Germany has ordered three high pressure Loeffler boilers, each to have a capacity of 100,000 lb. of steam per hr. This is a result of good results obtained with present installations under 1,900 lb. gage pressure and 932 deg. F. total temperature.

Meridian, Miss., has engaged Burns & McDonnell Engineering Co., Kansas City, Mo., consulting engineer, to make surveys and estimates of cost for a municipal electric light and power plant.

During the past two years, Jamestown, N. Y., has paid off $700,000 from the profits on the sale of electric light and power on a contracted debt of $750,000 for the purchase of the municipal system. The property was secured from the Niagara, Lockport & Ontario Power Co., in 1931, and the municipality was allowed five years to defray an amount of $450,000, following the down payment of $300,000. During July, $50,000 was paid on a balance of $100,000 due at that time, leaving but $50,000 more to be defrayed. This is expected to be paid next year, or two years before the final payment actually is due.



Plans are under way by a number of municipalities in California for electric light and power projects, including generating stations, transmission and distributing lines, with bids for equipment scheduled to be asked during the next sixty to ninety days. Escondido has authorized a special election to vote bonds for $100,000 for construction of a municipal electric light and power system, with power substation and auxiliary structures; Hayward has secured a report from Edward K. Hussey, Syndicate Bldg., Oakland, consulting engineer, recommending construction of a municipal light and power plant, and distributing system to cost $240,000, with equipment, and is considering early call for bids; the last noted engineer is making surveys and estimates of cost for an electric distributing system at Clovis, with power substations, etc.; Compton is considering a municipal electric light and power plant to cost close to $150,000; Signal Hill proposes a municipal generating station to cost about $250,000, with equipment, and will have plans drawn in near future; Trulock has authorized its city engineer, H. C. Hall, to make surveys and estimates of cost for a proposed municipal light and power plant; Anaheim plans complete rebuilding of primary electric distributing system, and surveys, with estimates of cost, will be made by J. Edward Brown, Azusa, consulting engineer.

F. U. Ross, superintendent of Virginia Electric & Power Co., at Williamsburg, Va., stated that actual construction of the company's plant will begin at once. The plant will be built on Northington St.

American Brewing Co., Dayton, Ohio, organized recently by Geo. T. Matthews, Winters Bank Bldg., and associates, is planning a 150,000-bbl. brewery including power house and refrigerating plant, to cost about $500,000.

A fund of about $75,000 will be arranged by Central City, Neb., for a municipal light and power plant. Plans for station will be drawn at early date.

Newcastle, Ind., is arranging a fund of $448,000 for extensions and improvements to its electric light and power plant.

Appalachian Electric Power Co. will spend $75,000 at Lynchburg, Va., to improve and enlarge its electric power facilities, this being a resumption of the extension program for 1929 which was suspended that year. Eleven of the larger concerns using electricity at Lynchburg for power showed an increase of 61 per cent last month and slight increases are noted by the company in other uses of electricity for power and light.

Bureau of Power & Light, Los Angeles, Calif., has let contract to Blaw-Knox Co., Blawnox, Pittsburgh, Pa., and associated interests, Western Pipe & Steel Co., and Consolidated Steel Corp., both of Los Angeles, for proposed transmission lines from city to Boulder Canyon, Nev.

A bond issue of $133,000 is being sold by Beloit, Wis., for construction of a municipal electric light and power plant, for which plans are being completed by Kenneth R. Brown, 1608 Harlem Blvd., Rockford, Ill., consulting engineer. Proposed installation will consist of diesel engine-generator units.

Farrel-Birmingham Co., Inc., increased all hourly wage rates 10 per cent in its Ansonia, Derby and Buffalo plants, as of July 10. At the same time, the working week was made 40 hours.

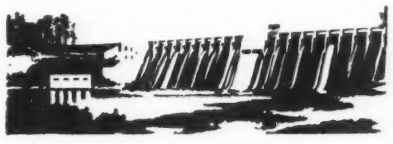
Virginia State corporation commission has set Oct. 10 for a public hearing of the joint petition of Chesapeake & Ohio Railway and Appalachian Electric Power Co. for authority to release the Lynchburg dam across the James river and the Kanawha canal from public obligation. The petition indicates that the power company will use the Lynchburg properties of the old canal for power development and that the canal itself will be ultimately discontinued altogether.

Seattle, Wash., in a revised application, will ask for $23,000,000 in Federal loans instead of the $18,500,000 previously asked for from the now defunct R.F.C. for development of the Skagit River project. This includes flood control work and a new dam near Ruby Creek, six miles above the new Diablo Dam.

A one-story power plant will be built by Southern California Brewing Co., Oviatt Bldg., Los Angeles, Calif., at new 6-story brewery in South Gate district, where tract of 6 acres of land has been purchased. Entire project will cost over $200,000. Bryant & Shaw, 1610 Cosmo St., Los Angeles, are architects.

Clearwater, Fla., is considering construction of a municipal electric light and power plant, estimated to cost about $125,000. H. H. Baskin, mayor, is active in the project.

Cape Girardeau, Mo., is planning a municipal plant. Utility franchise expires Nov. 5.



New Bulletins

Indicating Pyrometers—Mishawaka Industrial Instrument Mfg. Laboratory, Mishawaka, Ind. 6-page folder, indicating pyrometers, including unit designed particularly for diesel-engine cylinder temperatures and for flue gas temperatures.

Brewery Equipment—Allis-Chalmers Mfg. Co., Milwaukee, Wis. 12-page bulletin No. 149, power equipment for modern brewery and malt house.

Nickel and Alloys—International Nickel Co., Inc., 67 Wall St., New York, N. Y. 4-page sheet lists available publications on nickel and nickel alloys.

Wire Rope Slings—MacWhyte Co., Kenosha, Wis. 27-page catalog No. S-2, single and multiple-part wire-rope slings and fittings.

Filter Elements—Norton Co., Worcester, Mass. "Aeration and Filtration," Norton porous mediums as air diffusers, plates and tubes in sewage disposal plants.

Smoke Indicators—Ess Instrument Co., 816 Agnes St., Parkersburg, W. Va. 12-page smoke-indicator folder.

Hydraulic Couplings—Hydraulic Couplings, Inc., Detroit, Mich. Bulletin on Model F. D. hydraulic coupling for variable-speed fan drive.

Fire Brick—McLeod & Henry Co., Troy, N. Y. 16-page booklet, "Steel Mixture" oil brand fire brick, and other refractory materials.

Wrought Iron—A. M. Byers Co., Pittsburgh, Pa. Booklet, "The New Story of Ancient Wrought Iron," describes company's methods of making wrought iron.

Pipe-Fittings Compound — Technical Products Co., Pittsburgh (Sharpsburg Station), Pa. Sauer Eisen Technical Pipe Compound Folder No. 5, compounds for all kinds of pipe for various uses.

Oil Burners—Cleveland Steel Products Corp., Cleveland, Ohio, "Dollars From Empty Coal Bins," survey of oil-burner market conditions.

Diesel Engines—Superior Engine Co., Springfield, Ohio. 6-page bulletin, No. 128, on 4-cycle, solid-injection cold-starting stationary diesel engines.

Station Loads—Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. "Telemetering and Totalizing Station Loads," 16-page bulletin No. 874, discusses means for providing load dispatcher of electric power system with continuous information on load conditions throughout the system.

Spray-Deck Cooling Towers—The Marley Co., Kansas City, Mo. 15-page bulletin, No. 40, Marley spray-deck cooling towers.

Splash-Proof Motors — Century Electric Co., St. Louis, Mo. 4-page folder on company's splash proof motors.

Pipe Hangers—General Spring Corp., 11 West 42nd St., New York, N. Y. 4-page folder, on Genspring Constant-Support pipe hangers.

Boiler Tubes—Steel & Tubes, Inc., 223 East 131st St., Cleveland, Ohio. 67-page Handbook of Electric Weld Tubing, gives data on company's standard line of welded tubing.

Mechanical Soot Blower—Hahn Engineering Co., 30 Church St., New York, N. Y. 4-page bulletin No. 51, mechanical soot blower for fire-tube or horizontal return-tubular boilers.

Pressure Indicator—Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa. Bulletin No. 263, Maihak Type 2-CP engine-cylinder pressure indicator.

Reduction Gearing—Dominion Engineering Works, Ltd., Montreal, Canada. Two booklets, one 4-page on Dominion Farrel-Sykes reduction gearing, another on Dominion Gearflex couplings.

Pumping Station—De Laval Steam Turbine Co., Trenton, N. J. Reprint of article on new water filtration plant and pumping station at Highland Park, Ill.

Air Conditioning—American Blower Corp., Detroit, Mich. 24-page bulletin No. 3227 Series "R" "Sirocco" air conditioner.

Westinghouse—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. New bulletins include: 12-page circular on "Thermoguard" self-protecting motors, 4-page leaflet on Rectox battery chargers, 4-page leaflet on Copper Oxide Rectifying Units. 4-page leaflet on starting and speed regulating rheostats. 8-page booklet, C-1963, on small oil circuit breakers, utilizing condenser bushing. 2-page leaflet No. 20576 on small transformers.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Dothan—City Council plans extensions and improvement to municipal waterworks and light and power plant, incl. diesel engine, etc. $50,000.

Calif., Camarillo—State Dpt. P. Wks., G. B. McDougall, state archt., c/o Div. Architecture, Sacramento, completing plans rein.-con. power plant, State Hospital Grounds.

Calif., Hayward—City, making surveys municipal light and power plant. $240,000. E. K. Hussey, Syndicate Bldg., Oakland, engr.

Calif., Signal Hill—City, W. E. Henshaw, mayor, is negotiating for Federal loan to finance construction municipal electric light and power plant. $250,000.

Calif., Turlock—H. C. Hall, city engr, ordered to make surveys with view to establish municipal power plant.

Ga., Hopeville—City, c/o E. L. Johnson, City Hall, preliminary plans new waterworks extension, sewers and new municipal power plant. $150,000. Engineer not appointed.

Ill., Carlinville—Voted to establish municipal light and power plant and distribution system.

Ill., Greenville—City retained W. A. Fuller Co., engrs., 2916 Shenandoah Ave., St. Louis, to make preliminary survey for municipal light and power plant and distribution system. $150,000. L. Lloyd, mayor.

Ill., O'Fallen—Municipality plans electric power plant. To exceed $50,000. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., engrs.

Ill., Rockford—City, E. O. Strand, clk., plans municipal electric light plant. Engineer not appointed.

Ill., Springfield—City, c/o W. J. Spaulding, comr. P. Property, bids in August, 91x105 ft., rein.-con. power plant, $150,000. Will apply for loan under National Industrial Recovery Act. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ia., Morning Sun—Election Aug. 11, $70,000 municipal electric plant. I. M. Jamison, mayor.

Ia., Shenandoah—City plans waterworks improvements, incl. new pumping station on Nishnabotna River filtration plant, generator, auxiliary piping, etc. $125,000. Allen & Vagtoorg, 205 West Wacker Dr., Chicago, Ill., engrs. Have applied for loan under National Industrial Recovery Act.

Ia., Washington—City, A. N. Holloway, mayor, retained E. T. Archer & Co., engrs., 609 New England Bldg., Kansas City, Mo., to prepare preliminary plans municipal light and power plant and distribution system.

Kan, Anthony—City plans power plant, $60,000. Black & Veatch, 700 Mutual Bldg., Kansas City, Mo., engrs.

Kan., Burlington—City making plans municipal light plant. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Mass., Salem—Municipality plans pumping equipment for waterworks, and filtration plant. To exceed $17,500. Metcalf & Eddy, 1300 Statler Bldg., Boston, engrs.

Minn., Alexandria—City, H. S. Campbell, mgr., making plans new power plant equipment and alterations, incl; furnishing, installing turbine, generator, condenser, superheater, boilers and auxiliary equipment. Building alterations include concrete floors, foundations for turbine, pipe changes, etc. Est. $75,000. Burlingame & Hitchcock, 526 Sexton Bldg., Minneapolis, engrs.

Minn., Harmony—Village, J. M. Rostvold, clk., making plans complete waterworks system, incl. pump house, water tower and 20 blocks 4 and 6 in. c.i. mains. $19,000. E. G. Briggs, 1520 Hythe St., St. Paul, engr.

Minn., Isle—Village plans well, installing watermains and electric pumping equipment, steel tower and 20x20 ft. brick, tile building, $35,000. Will apply for Federal aid. S. A. Siverts, 454 Sexton Bldg., Minneapolis, engrs.

Miss., Meridian—City appointed Burns & McDonnell, engrs., 417 East 13th St., Kansas City, Mo., to study data in connection with attempt to get lower electric light and power rates and to furnish estimate as to cost of erecting municipal power plant.

Mo., Brentwood—City plans municipal light and power plant $150,000; sewer system $145,000; waterworks $45,000; city hall $35,000; Brentwood Bd. Educ., F. M. Taylor pres., for school $45,000. Contemplates applying for loan under National Industrial Recovery Act.

Mo., Clayton—City plans municipal light and power plant. $100,000. Contemplates applying for loans under National Industrial Recovery Act. Russell & Axon, Roosevelt Bldg., St. Louis, engrs.

Mo., Fredericktown—City plans filing application for loan under National Industrial Recovery Act for municipal light and power plant and distribution system. $100,000. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, consult. engrs.

Mo., Kennett—Election Aug. 6, $140,000, for municipal light plant.

Neb., Central City—City plans municipal light and power plant, incl. equipment, distribution lines, etc. $75,000. $40,000 now available for work, may apply for additional necessary funds under National Industrial Recovery Act.

Nev., Boulder City—Aug. 18, by Bureau Reclamation, Denvere, Colo., two or four 82,500 kva. and one 40,000 kva. vertical shaft, alternating-current generators, complete with main exciter, pilot exciter, thrust and guide bearings and surface coolers, for Boulder power plant, Boulder Canyon project, near here.

N. Y., St. George—Superintendent Lighthouses, St. George, making plans power house and improving fog signal at Thirty Mile Point Station. $28,400.

O., Cleveland—City, A. R. Brueggeman, dir. P. Utilities plans purchasing 35 m.g.p.d. steam turbine reduction gear drive centrifugal pumping unit for Division Ave. pumping station. L. A. Quayle, City Hall, engr.

O., East Liverpool—City plans municipal electric power plant distribution and street lighting system. P. F. Loftus, Oliver Bldg., Pittsburgh, Pa., engr.

O., Hudson—Village plans applying for Federal aid to finance construction municipal light plant. $50,000. P. W. Elwell, 4300 Euclid Ave., Cleveland, engr.

Okla., Skiatook—City plans new lake, 1.5 mi. 8 in. c.i. pipe and pumping plant, $60,000. Application made for Federal loan. V. H. Cochrane, Wright Bldg., Tulsa, engr.

Pa., Girard—City preparing survey municipal light plant. F. N. tSraus, 2613 Queenston Rd., Cleveland, O., engr.

Tex., Cotulla—Holland Dam & Irrigation Co., c/o J. B. Henderson, Majestic Bldg., San Antonio, c/o Mr. A. Holland, plans irrigation work, incl. wells, distributing lines, pumping unit, etc. $20,000.

Tex., Eagle Pass—Maverick Co. filed application for funds from P. Wks. Program, through R. Leeman, chn. South Texas Chamber of Commerce, Aztec Bldg., San Antonio, constructing gravity irrigation system and hydro-electric power plant. $1,843,925.

Tex., Floresville—City through R. Leeman, mgr. South Texas Chamber of Commerce, c/o Aztec Bldg., San Antonio, has filed application with P. Wks. Bd. for funds to finance construction waterworks and power plant improvements, incl. steel tank and tower, $40,000.

Tex., Rio Grande City—Starr Co. Water & Control Dist. 1, c/o H. P. Guerra, Sr., pres., Rio Grande City, made application for loan under terms National Recovery Act, constructing 1 pumping plant at Roma, consisting of 35 to 40 mi. main line canal to irrigate 24,000 acres. $1,200,000. Application approved by Texas Relief Comn.

Tex., Rockdale—City, c/o C. C. Smith, mayor, made application for loan under terms National Recovery Act to finance construction municipal light plant. $52,500.

Tex., Zapata—Zapata Co., c/o A. V. Navarro, judge, made application for loan under terms National Recovery Act for funds to finance construction power plant. $30,000.

Va., Radford—City soon takes bids hydro-electric power plant. $150,000. Wiley & Wilson, Lynchburg, engrs.

Wis., Edgerton—City voted to build municipal light and power plant. A. Geisberg, clk. Engineer not appointed.

Wis., Hartford—City, R. Abbott, clk., will build by day labor and purchase all material and equipment for pumping station and 100,000 gal. reservoir, deep well turbine pump and horizontal centrifugal pump. J. Donohue Eng. Co., Sheboygan, engrs.

Wis., Madison—Oscar Mayer & Co., plans 45x60 ft. power and boiler house. To exceed $30,000.

Wis., Two Rivers—City revising old estimates power plant. $250,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs. Will construct under Public Wks. Bill.

N. B., St. John—Forum Ltd., A. C. Clarke, pres., plans arena and ice plant. $75,000.

Ont., Pembroke—Pembroke Electric Light Co. soon takes bids concrete dam at power plant on Black River. $40,000.

Ont., Toronto—City, R. C. Harris, engr., City Hall, making plans concrete, brick, cut stone, steel pumping station building in connection with duplicate waterworks system. $750,000. Gore, Nasmith & Storrie, 1130 Bay St., consult. engrs.

Que., Montreal—St. Anthony Gold Mines, L. D. Wright, engr. in charge, plans installing this fall a 1,000 hp. hydro-electric unit and equipment for 125 ton daily capacity plant.
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